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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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Progress.

Way back in 1902 THE FOUNDRY TRADE JOURNAL first appeared, a modest little monthly journal, which a prominent foundryman recently described as resembling a theatre programme. It was found necessary in 1909 to increase the size and until 1921 it appeared with two 9-inch columns. In the latter year it was felt that the foundry industry could not adequately be catered for by means of a monthly, because business and technical associations of a powerful character had come into being, which carried out serious work, and for their wellbeing required the rapid dissemination of their work. Co-operation likewise demanded the rapid collection of news of foundry developments from the entire world. It was essential to know what foreign business and technical societies were studying. How this was met some seven years ago is a matter of history, and it is now a *sine qua non* that a monthly magazine is totally incapable of meeting the needs of an industry so important as foundry work.

During the seven years under consideration new bodies for the study of foundry practice have been inaugurated in Middlesbrough, the West Riding of Yorkshire, Burnley, Paisley, Falkirk, South Wales, Sheffield, Belgium, France, Czecho-Slovakia, Holland and various districts, such as Quad City in America. Additionally a system of exchange papers between the various technical associations of the world has become a regular feature in foundry life, and something like 150 high grade theses have been prepared. These contributions to foundry knowledge emanating from the sources indicated by no means exhaust the channels of new information, as there is a continuous flow from the various metallurgical and engineering societies of the world. It is our duty to collect, select and disseminate all the interesting material contained in any communication presented anywhere in the world. This task becomes increasingly difficult from one direction only—the limitation of space available for us. It has been decided once again to increase the size of the JOURNAL in the first issue of October. It will retain the existing width and length of the column, but there will be three on each page. It will allow of larger illustrations, where detail can be better shown; discussions on papers will not have to be held over for lack of space, and all the benefits to be gained from speed in the presentation of news will be realised. Additionally, the new size will enable us to devote a special section each week to non-ferrous metallurgical matters. This will be dealt with on the same rational plan which has made the JOURNAL so popular in iron and steel founding industries. This means that we shall not mistake abstruse physical chemistry for practical metallurgy. We are already assured of the closest co-operation with the leaders of thought in the non-ferrous foundry industry, and with increased space at our disposal we shall be in a position fully to utilise this co-operation without detracting in any way from the space we normally devote to the various sections of the iron and steel industry. The industry will appreciate that as it expands, both commercially and technically, so, too, will its representative organ make every endeavour to grow with it.

XUM

Foundry Query.

Cast Hollow Rolls.

For the query "Casting hollow rolls" having core diameters of 5 in. at the ends and 16 in. diameter at the centre and using a barrel of 3 in. diameter, I suggest that a steel barrel is used, but at the print end of the core a barrel of 2 in. diameter is inserted as far as possible into the 3 in. diameter barrel and wedged tightly so as to eliminate sagging. A bolt is put through the two barrels to prevent slipping when the core is on its end.

If the smaller tube is inserted as far as possible it will strengthen the larger barrel near the centre,

FIG. 1.

particularly so if they are wedged together tightly. This would give another ¼ in. of material each side, which would be a great help.

Very little "lapping" is necessary around the barrel at the ends, and where the core is 5 in. diameter a little hemp only need be used, as there is less chance of infiltration. Wherever there is great heat and strain, strawband burns quickly and leaves a considerable space, when infiltration can occur and may burn the barrel.

If the core is 16 in. diameter it is preferable to use rods to strengthen the body of the core, as shown as a four-way core iron in Figs. 4 and 5. As a suitable loam for the core I would suggest a rock sand, or preferably, on account of the length and weight of the roll, a composition made from old crucible pots mixed with a suitable

PRINT END OF CORE
STEEL OR IRON SHEETS LAPPED WITH WIRE TO KEEP IN POSITION.
STEEL SHEETS OR IRON LAPPED WITH WIRE TO KEEP IN POSITION.

FIG. 2.

binder. Probably a good rock-sand loam, finally "struck up" with the composition outlined, would be suitable.

It is also suggested that around the core of 5-in. dia. at the low end of the roll be covered with thin steel plates (tarred well), and held in position by lapping with wire. This would be a protection for the core at the bottom against heat and infiltration; also wrap and fasten pieces of sheet iron or steel around the 16-in. dia. part of the core. This would give extra support to the core when being turned up on its end to put into the mould. Plate of ⅛ in. thickness would serve.

It is presumed that the rolls are to be cast in the bottom neck, and whilst it is not mentioned

FIG. 3.

whether the metal is cupola or reverberatory furnace melted, the latter is preferable, as it gives a metal far hotter.

The inquirer may be interested in the arrangement shown in Fig. 3, which is used for "barrel cores." These are used for cores where heat and strain are encountered, and being solid, infiltration seldom occurs.

If the trestles are not sufficiently large in the groove to ensure a perfect radius when "turned," a piece of barrel is put on to each end to rotate on the trestles. In each corner a rod is placed and wire is lapped around (using a greased rod) to keep the vent rods in place. Then a thin lapping is added and the core is made in the normal way. To hold the core in position when turned up on its end, a washer is wedged at top and bottom. When the core is on its end, very *fine*, hard, perfectly dry coke riddlings are run into the vents, which can be filled up to the top or intermediately as required. By doing this a practically solid core with four good vents of an area usually equal to the area of the barrel which would be used is obtained. If a core has to be made where a good deal of loam has to be used in order to incorporate suitable rods, it should be accomplished by laying the rods on to the loam and fastening them with wire, as shown in Fig. 4. These rods strengthen the core in several ways.

FIG. 4.

By using core iron of this description one obtains strength, resistance to heat, and easy stripping, and eliminates the filling up the barrel. Alternatively the type of core bar shown in Fig. 5 can be used.

Such bars are of solid steel, and are slightly tapered. Four greased vent rods are placed in the slotted grooves and wired into position. Then the bar is lapped as a barrel. To turn the core bar, a hole is drilled to enable a small shackle to be used. To keep the core on the bar, washers or discs are placed both top and bottom, and are

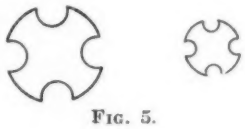


FIG. 5.

preferably fastened to the bar by an iron running through a hole drilled in the bar. The vents are filled as in the previous case. To keep the loam together, rods are used as above and wired.

The advantage of the bars is that, being tapered, the bar can be easily removed, and, being solid, it naturally gives a greater resistance to heat and the chance of infiltration is small. When in position the larger end diameter of the core bar is always at the bottom, where strain and stress are at a maximum.

It is hoped these few remarks and sketches will be of assistance, and if the inquirer cares to write me, care of the Editor, the data submitted will be amplified. A.M.I.B.F.

Patent Specifications.

The following list of Patent Specifications Accepted have been taken from the "Illustrated Official Journal (Patents)." Printed copies of the full Specifications can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1s. each. The last numbers given are those under which the Specifications will be printed and abridged, and all subsequent proceedings will be taken.

5,823. FINKELSTEIN, DR. A. Extraction of aluminium ore. March 2, 1926. (Convention date not granted.) 248,746.

11,990. HARRIS, H. Refining and separation of metals. May 7, 1926. 273,440.

14,083. PATON, J. D., and WOOD, A. Metallurgical furnaces. June 3, 1926. (Cognate Application, 21,781/26.) 273,457.

21,199. WADE, H. (International Nickel Co.). Addition material for ferrous metals. August 27, 1926. 273,523.

29,490. INTERNATIONAL COMBUSTION ENGINEERING CORPORATION. Boiler furnaces. (December 8, 1925.) 262,754.

31,357. PETERS, M. Production of rollers for tube-rolling mechanisms. December 10, 1926. 273,575.

1,036. DEAN, W., DEAN, F., and DEAN, J. Application of mineral blacking to foundry moulds January 13, 1927. 273,595.

9,883. KRUPP AKT.-GES., F. Moulds for manufacturing moulded cast pieces of corrosion-proof steel (e.g., chromium nickel steel). (February 18, 1926.) (Divided application on 266,305.) 269,208.

6,040. BRAGG, C. S., and KLIESRATH, V. W. Valve-control mechanism for fluid-pressure actuators for brakes. April 3, 1925. 250,193.

8,853. JAROTZKY, N. N. Process and apparatus for imparting a close texture to metals. April 1, 1926. 273,788.

8,906. NOELL, A. Cooling-beds for metal bars. April 1, 1926. 273,789.

11,292. HADFIELD, SIR R. A. Manufacture of steel products. April 29, 1926. 273,855.

Session on Cast-Iron Metallurgy.*

GERMAN RESEARCH WORK PRAISED.

DISCUSSION.

A New Era in Cast Iron.

MR. T. H. TURNER, of Birmingham University, dealing with the subject of the Paper, said he had been instrumental in starting a research on somewhat similar lines about a year ago, and he welcomed the success that Prof. Piwowarsky's preliminary Paper indicated. It was astounding to find a cast iron of 47 or 48 tons per sq. in. tensile strength, though that might not be a commercial matter yet. We might not yet have reached the alloy-cast-iron age in the way that—as Sheffield told us every day—we had reached the alloy-steel age (having passed the ordinary-steel age introduced by Bessemer), but Prof. Piwowarsky and others had shown that, at any rate, we were entering the alloy-cast-iron age. We could make this sort of cast iron, but it would probably be less expensive, for three reasons—its machinability, strength, and resistance to corrosion. It was extraordinary to find that Prof Piwowarsky's cast iron, of 45 tons or so tensile, machined as well as an ordinary one. Diesel engines, aeroplane engines, and machines of that type would call for the greatest strength and resistance to corrosion, and in that connection he mentioned that a Midland firm were making alloys with a still higher percentage of nickel and chromium than that mentioned by Prof. Piwowarsky, as corrosion-resisting material for ordinary purposes. The varying results that had been obtained in Great Britain during the past few years could best be seen in a still later bibliography than that mentioned in the Paper, *i.e.*, that prepared by Dr. Everest and published by the British Cast Iron Research Association this year. Most of the workers who had tried adding nickel and chromium to cast iron had made practically no alteration to the cast iron itself.

Nickel to be Added to Low Silicon Irons.

The advantage of nickel was obtained only when the silicon content was lowered, because silicon and nickel acted in the same direction in that they produced graphite, but the nickel did not produce it so much as silicon. Silicon tended to produce a coarse graphite, and nickel tended to produce a finer graphite, and in some cases, with extraordinarily successful heat treatment, it had given a truly fine graphite—so fine that it could hardly be seen under the microscope. The two alloys, steel and cast iron, must hang together when one bore in mind that one factor, graphite. By various means one could alter the size of the graphite, and that was fundamental in the strength of a cast iron. Every engineering achievement was now attained by the use of alloy steel. Major Segrave's car was built of nickel-chrome steel or nickel steel; the same applied to Lindbergh's aeroplane engine, so that when we wanted the best strength in cast iron it was essential that we should follow the same movement. The addition of nickel would never be successful unless we reduced the silicon, and he believed also that the best results would be attained with a combination of nickel and chromium, but the proportion must be like that of the alloy steels—the amount of nickel must be two or three times greater than the amount of chromium. Finally, he said that, since the very best results were attained with an alloy steel always after it had been heat treated, Prof. Piwowarsky was proceeding on logical lines in developing not only alloying but heat treatment also. That was not always necessary, however, and for mere machinability the addition of nickel alone, without heat treatment, had been successful.

DR. P. LONGMUIR welcomed Prof. Piwowarsky's Paper, not only because of its merit, but also because of the exceptionally good work which had been done in Aachen in connection with both cast iron and steel. Dealing with the author's brief reference, at the beginning of the Paper, to the work done in Germany and in other countries, Dr. Longmuir asked if he would state the method of melting, because a crucible-melted alloy cast iron should not be compared with a cupola-melted cast iron. A good deal of work had been done successfully in earlier days on the influence of what, in Sheffield, were called special elements, but much of that work had not been published. The author had opened out a field of very great promise to the foundry world in the after-treatment of cast iron, including quenching. Some years ago preliminary work was done at Sheepbridge, he believed, by the late Mr. Herbert Pilkington, a Past-President of the Institute, on quenching, with a quenching medium of clay wash, and some very promising results were then obtained. The author had also opened out an interesting field in the study of cast iron by producing a casting with the carbon in a state of combination, thus to a large extent eliminating crystallised graphite. Some very promising work was done by Royston, at Mason College, Birmingham, years ago on quick heat treatment. That work, unfortunately, had not been followed up to the extent that it might have been, but he (Dr. Longmuir) had had the pleasure of repeating some of Royston's experiments at Sheffield University, and of confirming them and carrying them forward to quenching. This work was done on crucible-melted cast-iron alloys. Commercial alloy cast irons, containing combinations of nickel, chromium, and other special elements, were being produced in Sheffield, and the extra expense entailed in producing them was amply justified.

Importance of Factors Other than C + Si Stressed.

MR. JOHN SHAW said that, although any Paper by Mr. Fletcher merited careful attention, he must confess to a feeling of disappointment with the present one. It was so general in character and was hedged about with so many qualifications that its practical utility was doubtful. The author was apparently obsessed with the idea of reducing everything to graphs and formulæ. His ratio $\frac{Tv}{T}$ might hold good when using the same mixture, and under standard conditions, but if the phosphorus content were increased to any extent a new ratio would be formed. This, for one thing, answered Mr. Fletcher's query with regard to the fact that tensile and transverse test results *so generally* showed differences in the ratio of the ultimate tensile to the rupture stress. Manganese and sulphur were stated to have an influence on strength. If that were admitted, it was necessary considerably to modify the statement that "The higher values of the ratio represent lower tensile strength, the curves showing these higher values as the silicon—and silicon plus carbon—contents are increased. It does not necessarily follow that the deflections of the transversely-tested bars will increase in the inverse sense to that of the rupture modulus-ultimate tensile ratios." The relation of Brinell also needed qualifying, as high phosphorus led to higher readings. The author had then proceeded to build up a theory concerning the dominating influence of total carbon plus silicon, a fact generally admitted, but not to the extent of leaving out the influence of the equally important factors of combined carbon, phosphorus, manganese, sulphur, mould temperature, casting temperature, and the effect of annealing, say, thin jacket cores on structure. One might cast a box of bars of 1, 1½, 2 and 3 in. dia. from one ladle. One would obtain a tensile of 12.9 on the 1 in., 10.84 on the 1½ in., 10.4 on the 2 in., 5.5 on the 3 in. All these bars would have the same total carbon plus silicon and $\frac{Si}{TC+Si}$, but what a difference there would be in the physical result due to the cooling action alone! Mr. Fletcher did attempt to rectify one objection to TC + Si = 5 or 4, in Table III.

D

* A discussion on "The Influence of Chromium and Nickel on High Quality and Heat Treated Cast Irons," by Prof. Piwowarsky, and "The Strength of Cast Iron," by Mr. J. E. Fletcher.

He had based his conclusions on the examination of castings, and he (Mr. Shaw) was quite prepared to accept the figures and tables for the particular type Mr. Fletcher had examined. On the other hand, most foundrymen had to visualise the effect of the various elements and the casting and cooling conditions before they could calculate a suitable mixture, which even then might be regulated by the stocks carried.

Correlation with American Experiments.

Mr. Fletcher had quoted from Mr. MacKenzie's Paper before the American Foundrymen's Association last year. The list of, roughly, 200 sets of bars, 2 in. by 1 in. by 24 in., warranted anyone's attention. They were tested on the flat. All the moulds were dried, and the bars cast vertically, top pouring being used. He had spent some hours studying the results, in order to see what confirmation of Mr. Fletcher's results they gave. Unfortunately, the tensile results were not taken. He had first collected all results (except very low carbons) that had a high impact value, and had averaged them. In order to find out the influence of phosphorus, he had extracted the high-phosphorus bars and had averaged them. Going a step further, he had taken all high-sulphur bars, except those with high phosphorus. The results were as follows:—

Table A.—*High Impact.*

Load. Lbs.	Def.	Imp.	T. C.	Si.	T.C. + Si.	C.C.	Mn.	S.	Mn./S.	P.	Brinell.	
3,454	0.39	16.5	3.1	1.6	4.68	1.02	0.47	0.125	4.05	0.35	243	High impact.
2,212	0.27	9.0	3.38	1.54	4.92	0.7	0.42	0.093	4.9	1.86	250	High P.
3,205	0.35	15.9	3.3	1.45	4.76	1.08	0.52	0.152	3.5	0.13	249	High S.
	Tons.											
Tensile =	12.5		3.35	1.10	4.45	0.55	0.62	0.095	6.5	0.5	138	Bush.
,,	8.16		3.3	1.14	4.44	0.05	0.58	0.101	5.7	0.39	89	Cylinder.

From Table A it would be seen that a high phosphorus lowered the breaking load, deflection and impact value, while there was a slight increase in the Brinell number. The high-sulphur results certainly showed the same characteristics, but to a smaller degree. This raised the whole question of the manganese-sulphur relation. If the whole of the sulphur were in the manganese-sulphur condition, the sulphur could have no effect on the stabilisation of the carbide. From where did the increase in combined carbon arise? This was much more noticeable in some of the bars than the average showed. The T.C. + Si formula took no account of the heated mould or superheated metal.

The Perlit Process.

Mr. Fletcher had mentioned the Lanz process, but it followed that if one ran a fair quantity of hot metal through the risers, one pre-heated the mould and altered the structure. The design of a casting had also a bearing on the structure. In a recent issue of "The Foundry" an example of that was given. Bars cut from the inner liner of a 25-ton jacketed cylinder gave 8.16 tensile, with a combined carbon of 0.05 per cent., and a Brinell of 89, while bars cut from a bush 3¼-in. thick, of approximately the same mixture, gave 12.5 tons tensile, with a combined carbon of 0.55 per cent. and a Brinell of 138. There was no doubt that the poor result shown in the cylinder was due to the annealing effect of the narrow jacket retaining the heat for a long time. This had not been allowed for in the composition, but would meet Mr. Fletcher's formula. He (Mr. Shaw) had not said this in any hypercritical spirit, for no one had a higher respect for Mr. Fletcher's ability than he had, but he was quite sure, from the pre-casting point of view, that it was better to deal with each job on its merits. He personally fixed the carbon, phosphorus and sulphur as low as his materials would allow, and let the thickness of the casting determine the silicon and manganese contents to be employed, aiming to obtain a pearlitic structure. Checking this with a chill test before casting was important.

Nickel-Chrome Cast Iron.

Discussing Professor Piwowarsky's paper, Mr. Shaw first complimented the author upon the large and valuable amount of work he had contributed to the improvement of cast iron. He himself had experimented with chromium and nickel additions for the last six years, and could confirm that the additions did not add much to the physical results, as tested, on bars; in fact, if much carbide were present, the material seemed more brittle under the direct shock test. On the other hand, in very heavy sections it appeared that the fine graphitic structure was carried right down to the centre, and in that case, therefore, gave greater strength. He had carried out a certain amount of work on the heat treatment of small castings containing 0.7 per cent. chromium and 0.45 per cent. nickel. It was found that the best results were obtained with a double heat treatment at over 950 deg. C. The Brinell was reduced from 512 to 269. Quenching in water was tried, with another object in view, and 713 Brinell was registered. His directors were now considering plans for the erection of annealing furnaces to deal with some of this work, which promised to branch out in several directions. Professor Piwowarsky's paper was a model of conciseness; every detail was given, and it was possible to repeat the experiments and compare the results. With regard to the piping, he suggested that possibly this was due to the bubbling action of the clay with which the chill was lined. He himself experienced no difficulty in that direction with much heavier sections cast in chills, with lower carbons and silicons, and about the same chromium content, but less nickel. The commercial aspect of castings of this type was the most serious. It was evident that a lined chill could not be applied to many types of casting. To get the structure aimed at in this investigation with composition alone left very little room for error either in analyses or works methods. To obtain the composition in Table I even demanded either an O.H. or electric furnace. It was very doubtful if the carbons could be obtained in the cupola with any certainty, even if all-steel charges were used; certainly the sulphurs could not. To the cost of annealing there must be added depreciation and interest in respect of the furnace. By this time one was approaching steel castings in cost of manufacture. He asked Professor Piwowarsky if he could give any advantage that could be claimed for such castings over a steel casting. That bugbear of the steel foundry, "flying," was also present in attempting to anneal complicated castings of this metal. They must be stripped as hot as possible and placed in a hot oven. To allow them to go cold and then attempt to anneal was nearly fatal, as he knew to his sorrow. These latter remarks, of course, did not apply to the small type of casting dealt with by the author. The salt-bath method might meet the requirements in that case.

German Results Confirmed.

Mr. J. G. Pearce (Director, British Cast Iron Research Association) suggested that perhaps the nearest commercial approach to the line of laboratory investigation followed by Professor Piwowarsky was not a steel casting, but a whiteheart malleable casting. He could not give figures at the moment to confirm Professor Piwowarsky's results, but the Association had done a little work on nickel and chromium additions and chill casting in respect of commercial whiteheart malleable iron. In some tests on the influence of nickel and chromium on commercial white iron of the malleable-pig type they had found that, in the annealed state, additions of from 1 to 2 per cent. of nickel and chromium did definitely

give better results; distinctly higher tensile strength, of the order of from 30 to 40 tons per sq. in., was obtained quite easily, and with additions of up to 1.5 per cent. of nickel the bend test was improved, *i.e.*, the ductility of the metal was improved. It was very difficult to compare the ductilities in the two cases, because they had used the bend test and Professor Piwowarsky had used the transverse test. Also, following the proposals of Mr. Fletcher, the Association had experimented on tough malleable iron with nickel and chromium additions, and had obtained some really remarkable results by casting malleable in chills. That, of course, might not be a commercial possibility at the present moment, but it did fit in very remarkably with some of the work the Association had in hand. Bars were cast in chills and in sand, and annealed under identical conditions. Sand bars bent 45 deg. before fracture, whereas the chill bars gave a perfect bend of 180 deg. and still showed no sign whatever of fracture. Those parallels might be interesting, in view of the similarity of whiteheart annealing and the heat-treatment adopted by Professor Piwowarsky. He asked if the Professor could give the elongations on the large tensile bars. It was difficult to see from the Paper whether the sand cast bars were actually heat-treated. Referring to Table I in the Paper, Mr. Pearce said there appeared to be one or two errors. The total carbon appeared to be about 2.26 at first, and after heat treatment it was 3.03.

Higher Elongation Sought.

MR. E. R. TAYLOR, A.R.S.M., F.I.C., said that the method outlined by Professor Piwowarsky, of pouring the superheated iron into chill moulds and subsequently annealing the castings in such record time, appeared to be a very economical means of producing small malleable castings of great strength but of moderate ductility. Such mechanical properties as 47.6 tons per sq. in. when using a nickel-chromium iron, and of 31.7 tons per sq. in. on unalloyed cast iron, were figures far greater than the usual 20 to 25 tons ordinarily obtaining in malleable cast iron. At the same time, the elongations registered, viz., from 2 to 4 per cent., could not compete with the 8 per cent. on 2 in. which was possible with whiteheart malleable. There should be many uses, however, for an iron of such unusual strength, even if the ductility were of a lower order. It was interesting to know that the results given by Professor Piwowarsky compared with those obtained in the malleablising of Emmel iron. Any successful means, however, of increasing the ductility beyond 4 per cent. would add very greatly to the value of the malleable produced. The real advantage of such a process was not so much in producing a super-strong metal as in obviating the necessity for long annealing; hence its possible economy. High-tensile iron was always possible in the production of whiteheart malleable provided the right composition was employed as the base. As an example, by using a high-manganese hematite iron with a composition Mn 1.25, S 0.13, and annealing for the usual period in the case of whiteheart malleable, tensile strengths of 32.5 tons per sq. in. and elongations of 3 per cent. on 2 in. could always be obtained. This composition base metal would anneal to a sorbitic state, as in the examples cited by Professor Piwowarsky. Such high tensile figures as the 47.6 tons per sq. in. obtained in his experiments were remarkable achievements, but any substitute for malleable cast iron required to have good bending properties, of at least 45 deg. in a ½-in. thick bar, in order to satisfy the malleable trade. He would prefer to call the product described by Professor Piwowarsky high-duty malleable cast iron, as distinct from the ordinary whiteheart malleable cast iron, because, apparently, it excelled in strength as distinct from bending properties.

MR. COLIN GRESTY (Newcastle Branch), discussing Mr. Fletcher's Paper, said it was surprising to him that so very little had been said about combined carbon. In the various analyses given by Mr. Fletcher, by far the greatest variation from the mean was shown in the combined carbon, and yet that was not plotted in Fig. 1, but everything was put down practically to the total carbon and silicon. It seemed to him that, since the combined carbon varied to such a very great extent, at least it ought to be plotted with the other things, because it might be a vital factor. On the whole he did not think the combined carbon got its fair share. Another point which had occurred to him in regard to the total carbon and silicon basis was that it depended always on a certain assumption, namely, that the cupolas were worked so that the concentration of both silicon and carbon, or the saturation of silicon and carbon, was complete, whereas he believed he was right in saying that practically all the modern cast iron developments with cupola irons depended on the exactly opposite fact, and foundrymen tried to work their cupolas so that they did not get the silicon and carbon both in a state of saturation. Commenting on Mr. Shaw's point that Mr. Fletcher had not dealt with the rate of cooling, he said Mr. Fletcher had explained, of course, that he had deliberately avoided it. He (Mr. Gresty), however, did not see how one could possibly wipe out the factor of the rate of cooling when considering processes such as the Perlit process or any other special processes in which the rate of cooling was, one might almost say, the predominant factor. In the Perlit process the rate of cooling was controlled by the heat of the mould. In other processes superheated iron was used, and he did not think it was right to draw the conclusions which Mr. Fletcher had drawn unless he really did take that factor into consideration. There appeared to be one or two little slips in Fig. 2A. For example, Mr. Fletcher had referred to the line BG. Apparently the G was at the end of the total carbon line, and F was apparently at the end of the silicon line, but had somehow got right down on to the base line. Mr. Fletcher had said he had found that by drawing the lines FB, GB, the total carbon and silicon contents of strong irons might be taken to vary between 3.0 and 2.6 per cent. Immediately following that he had talked of the compositions of the strong Perlit, Emmel and Corsalli cast irons, but he (Mr. Gresty) did not understand what Mr. Fletcher was getting at, because, in his experience of the Perlit process, at all events, 1.2 per cent. of silicon was the absolute utmost limit for very small castings. Actually it went down to less than 0.5 per cent. in his own practice, and, therefore, it was difficult to find a true basis for Mr. Fletcher's statement. From what he knew of the Emmel process also he did not think Mr. Fletcher was quite justified in putting a definite line, marked "2," on Fig. 2A, as showing Emmel iron. It seemed to be an attempt to confine incorrectly the composition of these special irons; they had much wider limits. For instance, he had shown that the composition of Perlit iron had a total carbon plus silicon of 4.4 per cent. A study of the Perlit patent specifications would show that anything from 3.4 to 4.6 was allowed. He would be glad if Mr. Fletcher would explain these points further, because the Paper was not an easy one to follow, and perhaps he (Mr. Gresty) had not got the correct understanding of the whole of Mr. Fletcher's views on the matter.

Ni and Cr Additions for Ordinary Castings.

MR. J. G. ROBINSON, Halifax, asked Prof. Piwowarsky if he had any information with regard to the use of nickel-chrome in ordinary grey iron castings, because he understood that it had been used very extensively for that purpose in the United States. An alloy was now being put on the market in this country with the elements balanced—nickel and chromium—and it was claimed that by adding this to molten metal in the ladle in correct proportions it was possible to produce castings with a low silicon and high combined carbon (up to 0.8 per cent.) which did not give a hard skin and thereby cause trouble in the machine shop, but which were easily machinable, had increased strength and wearing properties and a 25 per cent. increase in Brinell hardness tests. The approximate extra cost of such castings would be about a halfpenny per pound. He asked whether Prof. Piwowarsky had found it possible to add such an alloy to molten metal and obtain these results.

XUM

Empiricism Stifling Progress.

Mr. Horace J. Young, in a written communication, said that undoubtedly the addition of alloys to cast iron would be the future of improved iron, but commercially the subject was not sufficiently developed at the moment. Mr. Fletcher and himself had done much work on the heat treatment of iron, and it was possible to double its strength without affecting its machining qualities, whilst at the same time the Brinell was greatly increased. With alloy irons the effects would be even greater. That malleablising would take a few hours instead of days would also be possible, and if we had not fallen into the groove of empirical procedure such changes would have come about long ago. There was very much research going on nowadays with regard to alloy irons, and none was welcomed more than that by Prof. Piwowarsky.

Discussing Mr. Fletcher's Paper, he said that, when speaking of bars only 1¼-in. diameter, or of

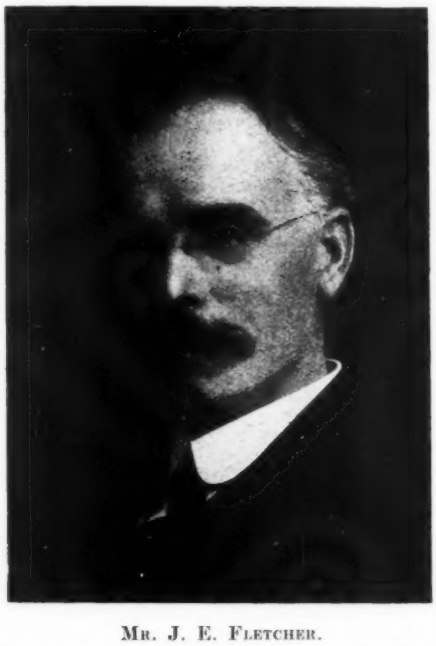
Prof. Dr. Ing. E. Piwowarsky.

Professor Piwowarsky, whose paper dealing with alloyed cast iron was so much appreciated, was up to 1922 lecturer in physical metallurgy at the Technical High School at Breslau, and also demonstrator in metallography and mechanical testing. In 1923 he was appointed to the chair of physical metallurgy and foundry practice at the Technical High School at Aix la Chappelle. Since that time the plant and facilities available for teaching foundry practice at Aachen have been materially augmented, until to-day it is excellently equipped for specialising in this branch of industrial research.

2-in. × 1-in. section, Mr. Fletcher had stated that the outer half of the bar area contained the best portion of the iron, which, if turned off, left a weaker and often micro-porous core. He had pointed to a case where a test bar cast separately had given a test 3 tons per sq. in. above that of a bar cast on the flange of a cylinder. He (Mr. Young) could point to cases met with in practice where separately cast test bars had given, say, 11 tons, whereas pieces cut out of the flanges (of turbines or cylinders) had given only about 7 or 8 tons. Competent authorities seemed to dread taking the bull by the horns, and he agreed that a nasty, unpopular bull he was. Still, the fact remained that test bars cast separately, when they weighed a few pounds each, and when the castings weighed many tons each, were about as useless and misleading as anything possibly could be. The fiction that because a test bar gave a certain strength the iron in the casting must be good was not worth discussion. As a matter of fact, the best metal for important castings would rarely make good test bars, and would be unsuitable metal if it did. Moreover, we needed to study our iron in the condition in which it was going to be used, and the grain size, the size of the graphite and of the pearlite, and of the phosphide, in a large casting were quite different from those things in any test bar. Wear, heat resistance, corrosive qualities, and so on were affected by these sizes, and it was high time that foundrymen faced the facts and, in the case of heavy and important castings, recognised that test bars cast as such were no longer to be seriously considered.

Pipe Trouble Overcome.

Mr. T. H. Turner, who acted as liaison officer between Prof. Piwowarsky and the speakers, and interpreted the reply to the discussion, said that Prof. Piwowarsky wanted to say first that he regarded the Paper as of classical value and not of immediate use. It was said that if the research workers were continually trying to get the strongest cast iron they would have to be stopped by the producers, because the latter said that the former were increasing their difficulties, but it was the research worker's job to try to point out the way to do it, even though they did not claim that the producers could do it at once. Prof.



Mr. J. E. Fletcher.

Mr. Fletcher was trained in Sheffield and at the Royal College of Science and School of Mines. After some practical experience as a moulder, he joined the staff of Messrs. Thos. Firth & Sons, Limited, as foundry manager, and later acted in a similar capacity to Messrs. Cammell, Laird & Company, Limited, but in addition took charge of the melting shops, forges, tyre and spring works. Since 1905 Mr. Fletcher has been consulting engineer and metallurgical adviser to Messrs. N. Hingley & Sons, Netherton Ironworks, Dudley. Ever since the inception of the British Cast Iron Research Association Mr. Fletcher has acted in consultative capacity. He is a past-president of the Staffordshire Iron and Steel Institute, a member of the Institute of Mechanical Engineers, the Faraday Society, the Iron and Steel Institute, and the Institute of British Foundrymen. He has presented a paper on behalf of the last-named to the American Foundrymen's Association. His work on foundry sand testing has received universal approbation.

Piwowarsky agreed with Dr. Longmuir that we could not compare crucible-melted with cupola-melted cast irons, but pointed out that when, as had happened in some cases, the cupola was connected with an electric furnace, these results were of direct benefit, and could be translated immediately into works practice. Replying to Mr. Shaw, he said that the occurrence of pipes was due to the wrong pouring temperature. Also, in later tests, the phosphorus content had been altered, and by correcting those two factors he had been able to overcome the trouble with regard to pipes. Replying to Mr. Pearce's question as to elongation on large tensile bars, he said the elongation there was nil, because the bars started to fail from the centre. The sand-cast bars were heat-treated. The Professor had noted the error with regard to total carbon in Table I. With the exception of the top figure, it would be found that the agreement was pretty fair, the general rule being that, through carbon being burned off, the second figure to the right was somewhat lower. If one added together the combined carbon and the graphite one would find that they were generally

a little lower in the right-hand column than in the left-hand column, because of the carbon being burned away.

Longer Treatment Gives Higher Elongation.

In reply to Mr. Taylor, he said the elongation was low, but that depended upon the length of time of the annealing process. The annealing period was a very short one. If it had been altered from 15 minutes to, say, an hour, it was possible to sacrifice some of the high tensile strength and to get elongations up to 10 per cent., or still more, according to the tensile strength. Replying to Mr. Robinson's question as to whether it would pay to add nickel and chromium to a ladle of ordinary grey iron, he said that, naturally, figures so high as were shown in the Paper could not be so obtained, because the figures in the Paper had been obtained by additions and superheating. The fine graphite structure could be obtained by the superheating, but the addition of nickel and chromium was an everyday commercial proposition on the lines indicated by Mr. Robinson. It was important to point out that the work described in the Paper was not yet finished, and that tests were still going on. For example, the repeated impact test on some of the new metals had exceeded 250,000 blows, and was still going strong.

MR. F. J. COOK asked what was the weight of blow.

MR. TURNER replied that the weight was 3 kg., on the standard Krupp testing machine.

MR. PEARCE said he gathered that the tests were made with the smallest drop.

MR. TURNER replied that the drop was 30 mm. With regard to bends, Prof. Piwowarsky had not carried out a bending test, but only a transverse test.

MR. FAULKNER said some misunderstanding had probably arisen because the usual German word for "transverse," was translated by the average technical translator as "bending." He did not just remember the different words in German for "bending" and "transverse," but in French "transverse" was "flexion" and "bending" "pliage."

Si and C Contents and Brinell Hardness.

MR. FLETCHER, replying to the discussion, said that if one took into consideration variations of manganese, phosphorus and other elements, and the effect of rate of cooling, etc., one would never get anywhere, and for that reason he had felt that by narrowing the results down to those in a regular type of practice one would be able to get figures that would be of some use to the student. The Paper was naturally one for study, and a very difficult one to criticise at short notice. With regard to the Brinell figures, he said these had been very carefully reproduced. In Figs. 2 and 3 there were given the results of MacKenzie's work, showing that there was a relation between Brinell hardness and the silicon and total carbon contents. He did not think it could be questioned that the variable qualities of these bars were not due to unsoundness, but to casting conditions. It might be said that the view that the sum of the total carbon and silicon content was of any moment was out of date, that it was an old-fashioned concept, and that the work which Ledebur did some years ago had been supplanted by more recent work. He would be as little likely to accept that, however, as to say that Prof. Turner's work on silicon was not fundamental. We should give honour where honour was due, and preserve the names of men who had done so much for metallurgy. Of course, one could see that if the sum of the total carbon and silicon was 4 per cent., it might mean 4 per cent. total carbon and no silicon —or nearly that—or it might mean the very opposite. It was the percentage of carbon or silicon in that sum that really mattered to any great extent.

Consideration of Special Irons.

He had not dealt in the Paper with special irons, such as the Emmel, Perlit, Corsalli, and so on, but had mentioned them in one or two cases simply because he had thought they would add some interest to some of the figures given. For instance, in Fig. 2A there were total carbon and silicon lines enclosing certain values. At points 1, 2 and 3 there were actual compositions from analyses he had made. He had not intended to convey the idea that those were the only compositions, for it was perfectly well known that those irons—Corsalli, Emmel and Lanz—had a range of analyses, as Mr. Gresty had mentioned. Mr. Young had called attention to the old trouble as to bars cast on and cast off, and that had been occupying attention for years. He had not gone into that question in the Paper, but had been concerned simply with castings which could be represented by a bar somewhere near 1.2 in. in diameter. In that we were at one with our friends in America, who had made their arbitration bar and settled it, and he thought that that bar settled it for the majority of cases. He hoped the study of the tables and the values given in the Paper would enable foundry students to get a little further with their ideas on the variations that occurred in castings cast under similar conditions.

Paris Convention Programme.

Round-Table Luncheon Talks Introduced.

The Paris Convention is to be held at the Parc des Exposition de la Porte de Versailles, from Wednesday, September 7 to 11.

Wednesday, September 7.

9.30 to 12.—(*a*) Opening of the Congress, Official Welcome, and Replies and Presentation of the Exchange Papers.
10.30 to 12.—(*b*) German Technical Session.
12.30 to 2.30.—(*a*) Luncheon to foreigners and authors of Papers offered by the Committee of the A.T.F.; (*b*) Round-Table Luncheon Talk on Light Alloys; and (*c*) Copper Alloys at the Restaurant attached to the Paris Fair.
Evening:—Reception with music and dancing in the rooms of the National "Arts and Métiers" Old Boys' Association, 9bis Avenue d'Iéna.

Thursday, September 8.

9.30 to 12.—Technical Sessions: (*a*) Cast Iron and Methods of Testing; (*b*) Organisation and Costing; and (*c*) English Speaking Session.
12.30 to 2.30.—Round-Table Luncheon Talks: (*a*) High Duty and Chilled Irons; (*b*) Steel and Malleable; and (*c*) English Speaking Delegates.
3.30.—Opening of the Foundry High School: Official Addresses, and an address by Mr. Portevin in the New Lecture Theatre on the Application of Macrostructure of Metals and Alloys. Visit to the Laboratories and Workshops.

Friday, September 9.

9.30 to 12.—Technical Sessions: (*a*) Cast Iron and Testing Methods—Steel and Malleable; (*b*) Copper Alloys and Light Alloys; and (*c*) Spanish Session.
12.30 to 2.30.—Round-Table Luncheon Talks: (*a*) Teaching and Apprenticeship Questions; (*b*) Spanish Language; and (*c*) Italian Speaking Delegates.
3.30 to 6.—Works Visits.

Saturday, September 10.

Closing Ceremony.—Technical Papers of General Interest and Distribution of Prizes.
12.30 to 2.30.—Round-Table Luncheon Talks: (*a*) German Speaking Delegates; (*b*) Czech Speaking Delegates.
3 to 6.—Works Visits.
8.—Closing Banquet, followed by dancing.

On the following Monday, and continuing until the following Wednesday, a first conference tour to the North-East of France, where a number of very interesting works will be visited. Details of this tour are available on application to Mr. T. Makemson, General Secretary of the Institute of British Foundrymen, at Saint John Street Chambers, Deansgate, Manchester.

The Theory of Superheating Cast Iron.*

The crystallisation of the graphite takes place according to the diagram shown in Fig. 1, "a," has reference to the carbon content of the saturated mixed crystals at the eutectic temperature. The carbon content of the mixed crystals is that part of the total carbon which is called "combined carbon" = "y." When the total carbon content is "a," the amount of the mixed crystals is 100, and therefore "y" = "a." When the total carbon content increases, the amount of mixed crystals decreases and "y" becomes smaller than "a." In the iron-graphite system "a" is 1.3. When a line JK = 1.3 is drawn which equals and is perpendicular to the base line AB at the point J (AJ = "a") and connect point K with point B, the ordinates of the line KB give the combined carbon values for the corresponding total carbon contents, on condition that the crystallisation follows the lines of the graphite system, and that no precipitation of graphite occurs after solidification. The angle KBA is very acute, and the line KB is nearly parallel to the base line. The part of the line KB which is important in the case of cast iron is shown in Fig. 2 on a larger scale (K_1B_1). The combined carbon content of the mixed crystals decreases when silicon is added. The position of the line KB in the diagram for different silicon contents is shown in Fig. 2. When we plot the silicon content on a line perpendicular to the drawing plane and lay a plane parallel to the y-Si-plane at the point of 3 per cent. total carbon, we get the line E_1E_n shown in Fig. 3. Though this line is only valid for a total carbon content of 3 per cent., we can regard it as to be correct for all total carbon contents as the inclination of the line KB (K_1B_1 to K_nB_n) is very small. The line E_1E_n, which gives the combined carbon contents of cast iron at the eutectic temperature for different silicon contents is the fundamental curve for the theory of superheating cast iron.

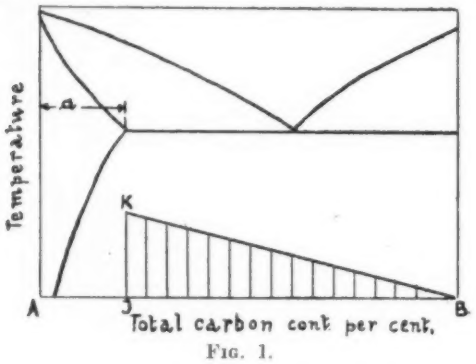


Fig. 1.

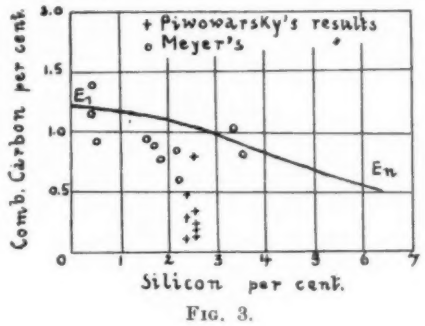


Fig. 3.

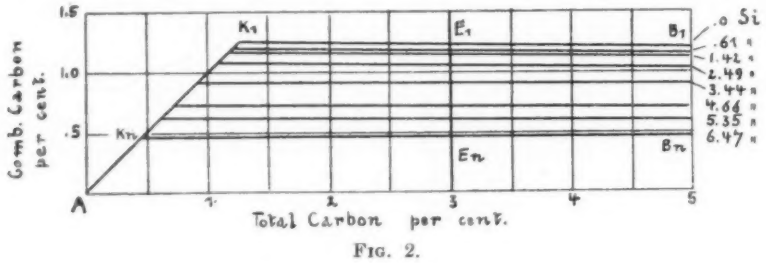


Fig. 2.

Now we must consider what conditions prevail when the combined carbon values lie on the curve, above the curve, and below the curve.

(1) *Where the values lie above the curve.*—As explained above, the combined carbon values cannot lie above the curve E_1E_n when the solidification follows the lines of the iron-graphite system. When the solidification occurs according to the iron-cementite system there is more combined carbon in the sample and the values lie above the curve. As the presence of carbides other than cementite is not likely, we may conclude that when the combined carbon values lay above the curve E_1E_n the solidification took place totally or in parts according to the cementite system, or, when the solidification took place according to the cementite system the combined carbon values must lie above the curve.

(2) *The values lie on the curve.*—This is the case when (*a*) the solidification takes place according to the conditions of the equilibrium and (*b*) when after the solidification no more graphite is rejected.

(*a*) When cast iron is molten at a temperature below the liquidus line it contains remnants of mixed crystals. When the melting period is short the carbon content of the mixed crystals is lower than that required by the equilibrium conditions, and after solidification the combined carbon values will lie below the curve. When the melting period as well as the melting temperature increase the equilibrium is attained and the combined carbon values approach to the curve. Besides the crystal remnants, the melt contains also undissolved graphite which lowers the carbon content of the mixed crystals. When the temperature or the melting period increases the graphite is dissolved and the combined carbon values approach to the curve.

(*b*) In solidified cast iron the decomposition of the mixed crystals occurs the more, the greater the surface of the graphite crystals is. The surface is the greatest when the graphite is rejected in the finely divided eutectic form. This is the case when the melting temperature is high. Therefore increasing the temperature means increasing the amount of graphite when cooling is normal.

(3) *Where the values lie below the curve.*—This case is the rule for cast iron. Superheating has, as shown above, two opposite effects on the combined carbon content. At first the one effect prevails (increase of the combined carbon content by approaching to the equilibrium), then the other (decrease of the combined carbon content by increasing the fineness of the graphite). Therefore the values will lie always below the curve E_1E_n, but in the case of superheating they will increase at first and then decrease.

Piwowarsky* has shown by laboratory experiments that when cast iron is superheated the values of the combined carbon contents firstly increase and then decrease. From this he concludes that there exists a critical temperature below which the carbon is present in the molten iron in the form of carbide, whereas above this temperature the carbon is dissolved in its elementary form. It is not necessary to accept this explana-

* H. Hanemann, "Stahl und Eisen," 1927, No. 17, p., 693/5.

* "Stahl und Eisen," 1925, p. 1455/61.

tion as shown above. Besides this Piwowarsky's values when plotted in Fig. 3 show that the solidification took place according to the iron-graphite system for all the values lay below the curve. The values of Meyer,* who checked Piwowarsky's results by experiments on a larger scale, lay for the greatest part below the curve, too. The two values which lay above the curve belong to chill castings (the silicon content was below 1.0 per cent. and the texture contained ledeburite). On the other hand, v. Kerpely† in his experiments did not find the critical temperature. When cooling is accelerated the inversion of the combined carbon values will not be encountered. On the other hand, by varying the melting period the inversion will be found or not at various temperatures. Therefore it may be concluded that the theory of Heyn-Charpy (the double diagram) is still valid and that the phenomena of superheating cast iron are correctly explained by it.

Making Chilled Rolls.

By S. R. ROBINSON.

[*This article is written in support of the pleas made by "Corbus" in a recent article. The author is Chief Metallurgist to Industrial Works, Bay City, Michigan, U.S.A.*]

The very interesting article entitled, "Chilled Roll Making," by "Corbus," in the April 7 and April 21, 1927, issues of THE FOUNDRY TRADE JOURNAL, recalls to the writer's memory his own rather brief experience in this most difficult branch of the metallurgy of iron in 1918 and 1919. At that time the writer was asked to take charge of the metallurgical end of a manufacturing plant producing converter steel castings, cast-iron castings, chilled iron rolls and sand iron rolls. He was also expected to erect and put into operation a 30-ton acid open-hearth furnace fired with fuel oil for alloy iron rolls.

His experience up to that time had been in blast-furnace work and in steel castings made by the converter and open-hearth processes. The old saying, "fools rush in," applied in this case as far as the chilled iron roll making was concerned. Being assured by the management that plenty of advice and experience were available at the plant as well as the coaching of a retired export chill roll maker, the work was undertaken, although with many misgivings.

Liquid Fuel Unsuccessful.

Starting early in 1918 the first question was the matter of a proper fuel for the air furnaces. Being a war year, high-grade Westmorland gas coal was not to be had, so fuel oil was used. The air furnaces used were known as the "camel-back" furnace. The furnace differs from the standard air furnace in several respects. The metal is charged at the side directly in front of the firebox as in the standard furnace, but instead of forming a bath at this point, the molten metal flows down a sloping hearth towards the further end of the furnace away from the firebox, so that when the charge is melted there is no metal remaining where it had been charged, but has flowed away to form the bath at the further end, said bath at times being 12 in. to 14 in. deep and rarely under 10 in. in depth. One big advantage of the standard air furnace over the "camel back" furnace is that the bath in the former is formed where the metal is charged, the molten metal helps to undermine the metal still unmelted and thus makes a quicker melting heat. The bath is not so deep in the standard furnace, and it can be heated up, whereas it is difficult to heat up a deep bath. Likewise the bath in the standard furnace is the hottest part of the furnace as shown by the greater tendency of the roof brick to fuse at this point.

The coaching of the retired chill roll maker was of great assistance in picking out scrap and pig-iron in making up the charges. His knowledge of chemistry was very limited, but his ability to mix by fracture was almost uncanny. His assistance when it came to operating the furnace with fuel oil was of very little value, as his experience with this fuel in an air furnace was as limited as the writer's. In the type of furnace used it was necessary to *melt hot*. As stated previously, the metal flowed away into a deep bath and it was extremely difficult to heat up this deep bath. Fair results were obtained with the heats for the large rolls as the temperature did not have to be so high, but indifferent results were obtained on small rolls, that is those 9 or 10 in. dia. and 20 ins. long.

By a special priority order from the Government, we were able to obtain a good gas coal, and we immediately discarded the fuel oil. Things went along much better. A good temperature could be obtained and the scrap loss on the small rolls was greatly reduced. However, with this type of furnace it was almost impossible to melt a really *hot* heat. Holding in the ladle after tapping to lower the temperature was seldom necessary.

To make successfully good small chilled iron rolls it is necessary to have hot metal. Small rolls should be poured just short of a temperature that will burn on to the chill. With a hot heat it is not necessary to get as deep a chill on the test piece before tapping, and the danger of cold shots is minimised.

Fracture Tests.

There are many open-hearth steel melters who pride themselves on their ability to read carbon by fracture, and the writer, while not detracting a thing from this ability, will say "You ain't seen nothing yet," until you attempt to read a fracture for a chill roll heat. The steel man has the added advantage of a quick check analysis from the laboratory, while the chill roll maker has no such aid. The latter's variables are total carbon, silicon, manganese, sulphur, and phosphorus, and even were it possible to obtain a quick analysis of all five elements, he would still have the temperature and slag condition left to his judgment, with much less chance for judging the two last variables than the open-hearth man. The fractured chill test will vary from a deep grey backing with a sharp line of demarcation between it and the chilled portion, to a mottled backing with very faint spots of graphite leading into the chilled portion.

It was early in his experience that the writer had impressed upon him the value of using *chilling* pig-irons in the pig portion of the charge. That is, if the pig-iron portion of the charge was melted separately, one should obtain a definite depth of chill of, say, $\frac{1}{2}$ in., rather than to obtain the total chill from the scrap portion of the charge. The chill would be more stable, and the depth of chill obtained on the chill test piece would hold in the finished roll.

The matter of stability of chill opens up a field for much study. On cupola iron chilled rolls the chill is stable on account of the higher total carbon and higher sulphur and silicon. Air furnace iron having lower total carbon as well as lower sulphur and lower silicon does not have as stable a chill as cupola iron: the chill test piece on the air furnace metal may have a deep chill and the final metal poured into the chilled roll will not have as deep a chill as expected.

Pearlitic Cast Iron and Roll Making.

On this side cupola chilled iron rolls make up a relatively small proportion of the total chill roll tonnage. Cupola chilled iron is much harder and therefore more difficult to machine, and more liable to spall in service than air furnace chilled iron. We hear the term "mild" chill and "hard" chill, which refers to the actual hardness of the chilled metal itself. This hardness of cupola chilled iron is due mainly to the higher total carbon content. If the total carbon in cupola iron could be lowered by the correct use of steel scrap, and the proper operation of the cupola, and since sulphur can now be lowered to the same percentage as in any air furnace iron, there is no reason why cupola iron could not be used for a much larger percentage of the chilled roll tonnage. Much of the present day investigations being made on pearlitic cast iron, etc., should be

* "Stahl und Eisen," 1927, p. 294 7.
† See FOUNDRY TRADE JOURNAL, "Stahl und Eisen," 1925, p. 2004/8.

of interest to the chill roll industry. A cupola metal with total carbon from 2.80 to 3.00 per cent. with sulphur under 0.050 per cent. is made *regularly* in side blow converter steel foundries to-day. The chilling properties of this metal are well worth studying. The total carbon content of the cast iron from their recent development in cupola practice on the Continent, namely, the Poumay System, is worth while investigating. It is the writer's opinion that a much better chilled iron roll can be made from the cupola than has been made in the past, one which will practically duplicate the composition and properties of an air furnace chilled iron roll, and it is high time the chilled roll industry investigated the possibilities along this line.

Irregular Depth of Chill.

The matter of the irregularity of depth of chill is a problem. We are all familiar with the patches of grey iron that show up on the machined surface of the roll. Foundrymen often say they can bring about this condition at will by varying the thickness of the layer of blacking applied. Some have even gone so far as to insist that it is possible to crack a chilled roll by an extra heavy layer of blacking applied as a narrow strip vertically the length of the chill. Probably there is as much rule of thumb and superstition attached to the blacking of the chill, the composition of the blacking, its application, whether brushed on or sprayed on, as is attached to any other branch of chilled roll making. Some foundrymen will use a blacking of a certain brand from one firm only and would rather shut the shop down and wait for a new supply of their particular brand, rather than risk the scrapping of a heat through the use of a different blacking. Such a stand on the part of the foundryman should not bring forth an attitude indicating contempt on the part of one from the metallurgical department, as is often the case. The foundrymen's apparent whims may be very well founded, even though he is unable to state definitely just what the difference is between, say, two particular kinds of roll blacking. This is more an indictment of the chemist or metallurgist for not being able to determine just what the difference is, rather than the foundryman, and it should be a challenge to the former, so that he may be of more assistance to the chill roll maker. This same thought may be well applied to all lines in which the metallurgical department and the "practical" foundry organisation come in contact. Is it not true that the main trouble between the two lies in the inability of the technical man to "sell" himself and his ideas to the foundry?

Mixing Cupola Metal and Scrap.

The writer takes off his hat to the chilled iron roll maker! One is in no position to criticise until he places himself in the position of the foundryman with a 10-ton or a 20-ton heat in the furnace and has on his shoulders the *full responsibility* for the production of a product which must be perfect to meet present-day standards. The present-day metallurgist must realise that excellent chilled iron rolls were made long before his profession came into being, and one must face the fact that the art has received very little real assistance from present-day chemistry or metallurgy. It is very probable that this apparently backward branch of metallurgy would welcome assistance from the metallurgist, and it would also appear that this is an open challenge to the metallurgical fraternity to produce something tangible in the way of an improvement on the present "Rule of Thumb" practice. The relation between the chill roll maker and the metallurgist is in the same position as were the blast furnace and the chemist 30 years ago. It was up to the chemist at that time to break down the prejudice of the blast-furnace manager, and the same thing holds good to-day with chilled iron rolls. It is too much to ask of the practical man to tell all he knows until he is assured that he will get information in return that will be of assistance to him in his work.

The suggestion made by "Corbus" to mix molten cupola iron with the scrap charge in the air furnace is well worth study. This will require close control in the cupola with the object of keeping the total carbon low and the addition of soda ash to bring the sulphur in the cupola metal down to the air furnace iron sulphur content.

In regard to phosphorus in America, it is considered to perform a two-fold purpose, namely, increasing fluidity and preventing cracks.

The writer would add that the thoughts brought forward by "Corbus" in his excellent presentation of the subject are well worthy of close study by the chilled iron roll industry. We will all have to admit that there is certainly a woeful lack of knowledge of what transpires in molten cast iron when subjected to the quick cooling, otherwise known as "chilling."

The writer well remembers the difficulties encountered with what is called in America a "Chill Pass" roll. This is a sand iron roll with one deep pass near the centre made in a chill, the depth of chill in this pass being ¾ in. finished. A sand sample (not chilled) was poured on such a heat and fractured. What was desired was only a *few* scattered specks of graphite and how diligently one searched for them! Anything more than this resulted in grey iron in the chill pass, anything less, a chilled neck!

Catalogues Received.

Coke.—Of all the difficult material advantageously to advertise, we think coke is one of the most awkward. The adjectives used, such as, "silvery," "bright," "hard," "non-friable," are so very indefinite that they are almost meaningless. The method used by Messrs. G. R. Cawood & Company, Limited, of 1, Cavendish Road, Leeds, in a recently issued 28-page catalogue has been to give an excellent description of its manufacture by the by-product oven, the Beehive oven, horizontal gas retort and the vertical retort. By emphasising the influence of manufacture on the resulting properties a much clearer conception is gained. Typical products from the various ovens have been photographed and splendidly reproduced. A short description of crucible steel melting is given, followed by one on cupola melting. Just one little mistake has crept in here, where it is stated that "hematite pig and scrap iron is charged." We are afraid that this mixture would not make very fine gutters or fall pipes, but it might suit ingot moulds. We suggest that in the next edition this phrase should read "pig-iron and iron or steel scrap." We notice that the phosphorous content of coke ash is mentioned as being a possible source of trouble, but we can assure the author that the cupola is not likely to reduce the phosphorus in the coke ash, and if it did it would not matter much, as working at a 10 per cent. coke to iron ratio, and containing 0.01 per cent. phosphorus. it would only increase the phosphorous content in the resultant castings by 0.001 per cent.

The question of iron making in the blast furnace is next dealt with, whilst brass melting potholes receives a little consideration. A further paragraph is devoted to foundry practice on the last page. We congratulate the firm on having placed before the coke-consuming public a really interesting brochure. It is excellent in conception, and those of our readers who are fortunate enough to possess a copy will undoubtedly receive some benefit from its perusal.

Fluid and Plastic Metal Preparations.—Two pamphlets dealing with very interesting materials have been received from Messrs. Stewart Browne & Company, of 70, Victoria Street, London, S.W.1. The plastic preparations, so far as we can gather, are mixtures of true metallic powders agglomerated by some adhesive matter. These are used as metallic fillings for stopping blowholes and other defects. The fluid preparation is of a similar character, but is merely painted on with a brush. It gives a matte surface, which can be burnished.

Sir Alfred Mond has accepted the presidency of the seventy-ninth anniversary festival of the Royal Metal Trades' Pension and Benevolent Society, to be held on Tuesday, October 11, at the Hotel Cecil, London, W.C.

Stresses in Non-Ferrous Castings.*

SHEFFIELD GATHERING'S VIEWS.

Largest Crystal Grains Absent in High-Grade Manganese-Bronze Propellers.

Mr. Wesley Lambert (Vice-President) commented on the author's statement regarding the very large crystal grain structure to be found in some large marine-propeller castings. As one who had had a very considerable experience in the manufacture of heavy manganese-bronze castings, weighing up to 30 tons apiece, he pointed out that it would be a most alarming thing were the Paper to be allowed to be published broadcast without a correction being made. He felt sure that the purchasers of marine propellers and of other heavy manganese-bronze castings would be extremely chary about ordering these castings if there was even a likelihood of the crystal grain size in any part of a casting even approaching that shown in Fig. 3, which represented a single crystal grain of several centimetres diameter. He believed he recognised in Fig. 3 a crystal grain which he himself had loaned to Professor Desch. Professor Desch had published a Paper on the isolation of metal grains, and at the conclusion of that Paper had written that he hoped in the near future to succeed in isolating larger grains. He (Mr. Lambert) had sent Professor Desch the grain illustrated, and he could only surmise that, seeing it came from a propeller manufacturer, Professor Desch had concluded that it must have resulted from a very large casting, presumably a propeller.

Original Chill and Large Grains.

As a matter of fact the large grain in question came from a small bulk of metal weighing only about 200 lbs. Explaining the circumstances under which the large grain was obtained, he said that on a certain Monday morning manganese bronze was being extruded, and a chill-cast billet had fallen to pieces while being removed from the reheating furnace. Among the pieces of metal was found the large single crystal grain shown in Fig. 3. He was sent for and informed that there was something radically wrong with the metal as evidenced by the large grain structure exposed on the fractured surfaces of the billet. Inquiring as to when the billet was put into the reheating furnace, he was told that it was put in that morning. He came to the conclusion, however, that the billet had been put into the furnace on the previous Saturday morning, and that when the whistle to cease work had blown the men had not troubled to extrude the last remaining billet, but had allowed it to remain in the furnace until the Monday. Then, when the furnace had been fired on the Monday morning, the billet had been left at the back of the furnace, until at last it was brought forward for extrusion and had fallen to pieces as it was handled.

It is practically impossible, when following the ordinary routine practice, so to cast a propeller, even when weighing say 30 tons, as to produce a crystal grain of the size shown in Fig. 3. He had examined many propellers accidentally broken during the war, and in several instances sections had been cut right through the heavy root portion adjacent to the boss of a blade, planed, polished and etched, and he was in a position to affirm that it is extremely doubtful whether one would ever happen upon a crystal grain of a diameter larger than ¾ in.

The text of Professor Desch's Paper might lead one to believe that in large castings of manganese bronze one can find large grains of the size illustrated in Fig. 3 of his Paper, but this was not so, and he was sure Professor Desch would readily admit his error in this respect.

Composition and Large Grain.

Professor Desch, replying, expressed regret to Mr. Lambert for having misunderstood his communication. It was true that the grain referred to was the one Mr. Lambert had sent him, and he had inferred, from Mr. Lambert's letter, that it had come from a propeller. He was quite prepared to admit that grains in castings never were that size. However, he had had propellers from other sources with crystals of very large size, and it was, after all, a matter of degree. A crystal with a diameter of ¾-in. was pretty big, and he was referring to crystals which would break apart and give such a coarse fracture that the size of the crystals was visible to the eye. The cause of such unusual crystallisation was still obscure and was worth investigating. A simple cast billet of such bronze could not be made to give excessively large crystals by heat-treatment alone. When, however, there was any local chilling in a casting, cooling stresses might be set up, so that on re-heating the mass of metal was in a similar condition to a mass which had been cold worked, and therefore grain growth could take place. It was quite possible that the occurrence of exceptionally large grains in some propellers was due to such local stresses, but the conclusion had not yet been proved. It was remarkable that such grains were only observed within certain ranges of chemical composition.

Result of Insufficient Feeding May Resemble Contraction Stress Pull.

Mr. Wesley Lambert, reopening the discussion on the following day, said that he had again read Prof. Desch's Paper, and would like to bear testimony to the fact that it was a really valuable contribution, containing a considerable amount of very useful information. Discussing the Paper further, he called attention to the author's statement, in a reference to chill castings, that "When the chill is very severe, as in pressure die-casting, there may be great shrinking stresses, and this has been observed with aluminium alloys. Pistons, when die cast under pressure, have been known to separate into two concentric shells, completely distinct from one another, owing to sharp contraction stresses between the two rapidly-chilled surfaces." It so happened, he said, that a few days ago a member of the Institute had sent him a gunmetal plate, having a superficial area of about 2 sq. ft. and about ¾ in. thick. The casting appeared to be quite good, but the member in question had had occasion to machine it somewhat deeply, and had then found, to his great consternation, that there appeared to be some defect. In exploring it he had found that there was a wall space in the interior of the casting, and that it was possible, without very much trouble, to divide the casting into two distinct parts. This was not at all an uncommon thing in non-ferrous work when one was casting thin castings. Prof. Desch, apparently, would lead one to believe that it was due to contraction *stresses*. If it were due to contraction stresses, however, one would expect to find some evidence of rupture of metal, but, as a matter of fact, in the majority of these cases, if one examined the surfaces exposed by tearing the two apart, one found that the crystal formation had not been disturbed by fracture or rupture in any way. There were skeleton crystals and perfectly-formed crystals exposed, and he believed it would be found, if one examined them closely, that the trouble was due to a dual freezing, *i.e.*, freezing taking place on both sides of a thin casting, and that there was insufficient liquid metal to follow up the contraction. It did not appear to be due so much to contraction stresses as to the fact that one had not been able to feed the thin casting. In order to demonstrate that this was not at all uncommon, he said that on several occasions specimens had been sent to him and he had been asked for advice as to how to get over the trouble. The remedy suggested itself. One must endeavour as far as possible to get the freezing to take place from one side of a thin casting. That could be done by having one half the mould warm and the other half colder. He had met cases of pistons showing two concentric castings, one inside the other, but he had no evidence whatever that they had parted as the result of internal contraction stresses; the trouble was due to the fact that the castings were improperly fed.

* A discussion on Prof. Desch's Paper on "Stresses in Non-Ferrous Castings," which appeared in our last issue.

Burning-On and Annealing.

Later on in the Paper Prof. Desch had referred to burning-on at defective places as being a prolific source of trouble. Unfortunately, however, burning-on had to be resorted to, and Prof. Desch went on to say that such trouble could only be avoided by annealing. It was very kind of him to call attention to that fact, but all practical foundrymen recognised that when they had to have resort to burning-on, an annealing operation followed, otherwise there would be many more failures to record than were actually recorded. Reference had also been made to the cracking of valve castings used in the construction of the Catskill Aqueduct to New York. He had been asked, in 1915, by American authorities to contribute to the investigation into the failure of these valves. It was true that in some instances the valves had failed because of the burning-on that had been carried out, which apparently had not been followed by adequate annealing, but in some instances these large valves had failed because the core was not made in such a manner that it would collapse sufficiently to enable the casting to contract as it should have done normally. He did not think that, at the time the castings were made, the makers had understood the idiosynerasies of manganese bronze to the extent that they were understood to-day.

Manganese-Bronze Propellers.

A statement in Prof. Desch's Paper which needed a little explanation was to the effect that it was well known to all who had been concerned with the casting of marine propellers in manganese bronze or similar alloys that occasionally a brittle casting was obtained, which might fracture on a blow, invariably showing a coarse intercrystalline fracture. Such a statement, said Mr. Lambert, might arouse some suspicion in the mind of the purchaser of a propeller as to whether he had not got hold of one of the brittle ones. Some 15 years ago the high-tensile bronzes, *i.e.*, the bronzes of the beta range, were introduced, and on account of their high tenacity and good elongation they were considered to be an excellent material for propellers, so that a very large number of propellers was made in the beta bronzes. Unfortunately, however, these beta bronzes had to be controlled within very narrow limits, and he believed propeller manufacturers would concede that 14 or 15 years ago a rather brittle propeller blade or solid propeller might occasionally have been made, but he was pleased to say that to-day they knew the limitations of the beta bronzes.

The Mercury Test.

Discussing the mercury test, referred to by Prof. Desch, he said that with the beta bronzes, of a brittle character, one could get disintegration in a very short time, but the bronzes of the alpha-beta type, which were used more than the wholly beta bronzes, did not disintegrate in mercury to anything like the same extent. He had asked Prof. Desch whether he had arrived at an explanation of the inter-penetration of mercury, and the reply was that he was still carrying out research work in that direction. The penetration of manganese bronzes, particularly the beta bronzes, by mercury was a very interesting phenomenon. Incidentally, one would gather from the Paper that the late Prof. Huntington had discovered this remarkable effect of mercury on bronzes. Dr. Rogers was credited with having first published this effect, but, as a matter of fact, it was within his (Mr. Lambert's) knowledge that some years before Dr. Rogers had dealt with the subject the effect of mercury on brasses had been discovered as the result of the fulminate of mercury used in the detonating caps of cartridge cases having caused the fracture of a very large number of cases.

MR. A. LOGAN was glad that Prof. Desch had drawn attention to the question of volume changes during solidification, because this point, particularly with regard to non-ferrous alloys, was one on which a great deal more information was required. He had experienced with gunmetal what Prof. Desch called "apparent expansion." If one had a gunmetal liner, for instance, 10 ft. or more long, 14 in. dia., and, say, 1½ in. thick, and moulded it in a box which was rather small, so that there was only a small thickness of sand on the joint, it was quite possible to see the result of the actual expansion of that casting. It was such that the two halves of the box were actually forced apart, and one could see the red casting showing through the joint. That was a case in which expansion was not merely "apparent," but very real. Prof. Desch explained it by saying that it was due to the thrust of the crystals. Whatever it was due to, it was very interesting, and was a point which required further investigation. Of course, the final result was a contraction or shrinkage. The statement in the Paper, already referred to by Mr. Lambert, that it was well known to all who had been concerned with the casting of marine propellers in manganese bronze or similar alloys that occasionally a brittle casting was obtained, was incorrect, and likely to be misleading. This point had been effectively dealt with by Mr. Lambert, however, and he (Mr. Logan) would only add his own confirmatory evidence.

Prevalence of Contraction Strains.

MR. H. C. DEWS (London) wrote that, on reading the first two sentences of the Paper, the practical foundryman is likely to be seriously perturbed by the reflection that yet another worry is being added to the already multifarious troubles he has daily to overcome. It seems desirable to ask Prof. Desch if he intended to convey that the position is quite so serious as his words may lead one to suppose. Considering the large number of castings which are put into service "as cast" one cannot imagine the presence of internal strains to be very widespread. If internal stress were liberated during the life of the castings one would expect deformation or cracking to occur. Such cases, however, are seldom reported, and even in the latter event the cracks can generally be ascribed to causes other than internal stress. One is thus forced to the conclusion that the internal stress is locked up harmlessly in the casting till, in the course of years, it finds its way back to the scrap-heap, or else stress is not present to such an extent as may be presumed. There is little doubt, as Prof. Desch points out, that "burning" is a prolific cause of dangerous internal stress, but the severe local heating and cooling in this case is not usually met with in the ordinary cooling of a complete casting.

It is difficult to agree with Prof. Desch that volume change on solidification is responsible for internal stresses. It is well known how metals and alloys rapidly lose their strength at high temperatures. Researches seem to indicate that the fall generally persists to a very low value, and although at some temperature below the melting point the temperature-stress curve may straighten out, it seems reasonable to suggest that near the melting point the strengh of most alloys is only of the order of a few pounds per square inch. No internal stress of any appreciable magnitude could be held by an alloy in such a weak state.

There appears to be a little confusion in the reasoning of the paragraph which states that coefficient of expansion figures are of little value to patternmakers in dealing with shrinkage allowance. It can readily be agreed that good working rules can be obtained by measuring actual castings, but it is sometimes desirable to have a more scientific check on these figures. This can be calculated from coefficient of expansion data where such are known up to near the melting point of the alloy. Figures from ordinary temperatures to near the melting point are not generally available, but in cases where they are known remarkable agreement can be seen to exist between the net expansion obtained from those figures and that found empirically by the patternmaker. It is important also in making such a comparison to deal only with sound castings, as the presence of internal cavities may seriously affect the apparent shrinkage. In choosing aluminium alloys to illustrate his remarks Prof. Desch has confused that portion of the total shrinkage which the foundryman has to contend with and that which is rectified by the patternmaker. The difficulty in the foundry with some aluminium alloys and the ease with which others may be cast is due to a high liquid contraction and volume change on freezing in one case and low values in the other. The foundryman can make good the liquid contraction

and volume change on freezing by suitable feeding and the pattern has to rectify the solid contraction, which may be much the same for alloys with very different liquid and pasty contraction values. No allowance which the patternmaker can put on will make good the shrinkage which takes in the liquid, and on passing to the solid, and conversely, once these two stages are past, none of the foundryman's artifice can make good the solid contraction. From this point of view it would not seem reasonable to expect published data on the solid contraction to agree with the foundryman's observations which refer to the alloy in the liquid and pasty stage.

MR. S. B. HOLE wrote asking whether Dr. Desch considered that disintegration of bronzes by action of mercury is due to penetration of mercury into the intercrystalline cement which (due to strain to which it is subjected) amalgamates much more readily. The strain gradient present probably causes an "active" condition in which an amalgam is formed and the cohesion between grains being destroyed, disintegration takes place.

Author's Reply.

Professor Desch wrote in reply that the use of mercury salts for the detection of stress in severely cold-worked metals, such as brass cartridge cases, was, he was well aware, known many years ago. The separation of grains of beta brass in a casting by immersion in mercury was quite a different thing, an effect which had not yet been explained, and possibly unconnected with stress. He first learned of it from Professor Huntington, and he was not aware of any previous observation of the kind. The statement in the Paper was therefore correct. He was not prepared to say whether the explanation was that suggested by Mr. Hole. This was one of the cases in which the hypothesis of the amorphous cement fitted the facts well, but he was not ready to commit himself to that hypothesis without further investigation. Mr. Dews had rather missed the point of the remarks concerning expansion figures. The coefficient of expansion was a most useful figure to know for the purpose of calculating contraction allowances. Unfortunately, it was known for very few alloys, and most of the published figures, especially for aluminium alloys, were worthless. The extent of the volume change during solidification was chiefly of importance for die-casting. It was quite unknown for most metals, and it was only lately that an apparatus had been devised and constructed in the University of Sheffield, by means of which that quantity could be determined accurately.

Novel Design for Gear Wheels.

Hill Clutch Foundry Company, of Cleveland, Ohio, U.S.A., has placed a novel design for gear wheels on the market. The design consists of an annular forged ring in which is cast a hub either with web or arms, depending on the size. After casting, the gear is machined and the teeth are cut. In making the weld between the steel and cast iron, the steel surfaces are brought in touch with a heavy current of hot molten iron. The amount of steel surface and of the extra iron poured against the steel is proportioned to the diameter and the face and pitch of the gear, or to the diameter and face of the flywheel in case this is being made. The annular forged ring is dense, uniform tough steel, without blowholes, hard spots, slag inclusions or other imperfections. The semi-steel centre requires no annealing, and hence there is no warping. The junction of the steel rim and semi-steel centre is a laminated weld of steel and iron, and the finished gear is one integral piece. The semi-steel centre is produced with standard-pattern equipment to insure uniform design. It is claimed that by applying the same idea to flywheel construction practically indestructible wheels can be made for high speeds.

International Federation of the Technical Press.—The International Federation of the Trade and Technical Press, whose headquarters are at 38, Cours Albert I, in Paris, will hold its third International Congress this year from September 20 to 30 in Berlin, after having met in the preceding years in Paris and in Rome.

Random Shots.

The Sheffield Convention was a fresh revelation of the social possibilities of the foundry world. The gathering was thoroughly representative, and City, University, and Cutlers' Company gave loyal and unstinted support to the new President, who set a fresh standard of excellence in presidential addresses, and incidentally created fresh problems thereby for his successors.

* * *

The ladies were charming, and since they made the dances possible, it is to be hoped that at Leicester they will be numerically stronger than ever, to help us dance the Heebie Jeebies or whatever other American importation may be the craze of the moment. In any case they can rest assured that they will be in a most enviable minority.

* * *

At the banquet we were fortunate in having present Sir Henry Hadow, who is reputed to be among the most brilliant after-dinner speakers in the country, and Mr. W. L. Hichens, one of the most far-sighted of our industrial leaders. The Lord Mayor, leaving aside for once his favourite slogan "Let's talk of Graves," talked of Sheffield with a faith and pride that might well be the envy of any Lord Mayor in the country. We harbour no doubts as to the sincerity of ceremonial addresses in general, but in his hands they acquired a spontaneity and a vitality that gave them an entirely new value. They had not, as it were, become staled by repetition.

* * *

Turning to more frivolous subjects, may we be permitted to inquire who had the temerity to have a pair of trousers cut after the style of one of the more responsible of His Majesty's Ministers, and has he thereby been helped at all towards occupying the seats of the mighty? We should also like to know how many toasts were drunk at the gathering of the Lancastrian clans, and why certain members of the party preferred stalls to the circle at the Hippodrome? And whether the red and green light scheme was really a success? And if so whether the idea might not have been still more useful at the banquet?

* * *

The award of the Oliver Stubbs Medal to Emeritus Prof. Turner was very popular, but in the gift of a grandfather clock to Mr. Shaw, the recipient seemed to fear some possible inner significance. Nothing was further from his thoughts, however, than to look a gift clock in the dial. . . .

* * *

Advertising men are usually considered to be enterprising, but the way in which they managed to hitch the Government and the Press to the Olympia Convention was little short of marvellous. If it could be done for the 1929 Foundry Exhibition, in London, one feels that an attendance of 125,000 and a profit of £10,000 might be very useful to the industry. . . .

* * *

These August days are proverbially newsless days—the journalists being, after all, but human, and having a fancy for a bit of holiday themselves now and then. But this year the papers seem determined to offer us compensation in the shape of various entertaining pastimes. If you study their advertisement columns, for instance, you will find that by smoking four million "Plus Four" cigarettes you will be able to present the wife with a handsome new scrubbing brush. Or alternatively, you can persuade the wife herself to use Messrs. Tip and Top's Tea, four hundred packets of which will furnish sufficient coupons for a new tobacco pouch. . . .

* * *

It seems a pity that this admirable example is not followed in the foundry world. Perhaps we are, as a group, less imaginative than our brethren who manufacture soap and cigarettes and tea. . . . But it would be infinitely more satisfactory to collect coupons from every truck-load of Messrs. Grit and Gravel's moulding sand, in the hope some day that the postman might bring you, say, a new pan mill!

MARKSMAN.

The Growth of Cast Iron.

K. Sipp and F. Roll* studied the growth of cast iron when subjected to (*a*) steam at temperatures of 400 to 450 deg. C., (*b*) heating at temperatures of 600 to 1,000 deg. C., (*c*) when used as fire bars.

(*a*) The composition of the cast-iron bars, which had a length of 100 mm. and a thickness of 15 mm., is given in Table I. The ends of the bars were furnished with silver stoppers in order to facilitate the measurement. The bars were exposed to steam of 400 to 450 deg. C. for 1,000 hours with a daily interruption of 10 to 12 hours.

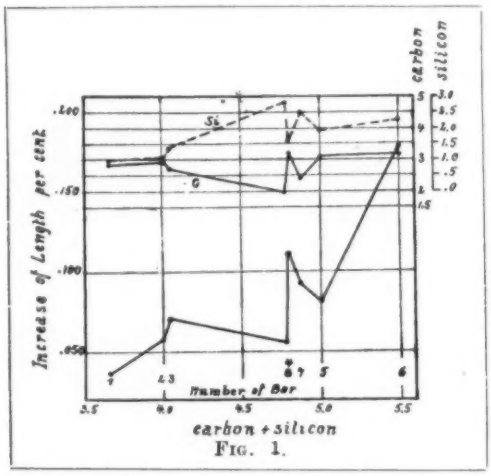


FIG. 1.

After the treatment the length of the bars was measured and the texture microscopically examined. In Fig. 1 there are plotted the changes of length in relation to the carbon + silicon content. The curve shows that in general the change of length increases when the carbon + silicon content increases. Bar No. 5 is not quite in accordance with this tendency, a fact which cannot be explained. When the carbon content is lowered and the silicon content is raised by the same amount the change of length increases, as is seen from the bars No. 7 and No. 8. From this it is seen from Fig. 3. A relationship between the change of length and the contents of sulphur, manganese and phosphorus respectively could not be stated. The microscopic examination showed that the texture of bar No. 1 had not changed. The other bars showed an increasing sponginess of the graphite (especially near the edge) and corrosion phenomena. In the case of bar No. 5 these changes were very small. Contrary to

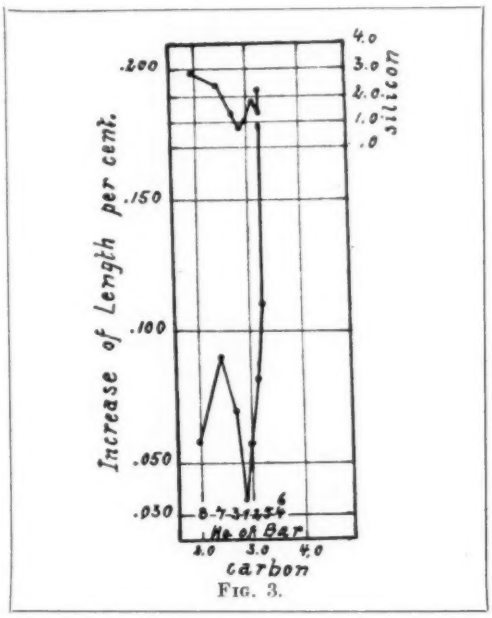


FIG. 3.

Piwowarsky's observations, the carbon content had not decreased after the treatment. The formation of temper carbon could not be observed.

(*b*) The composition of the bars which had the same dimensions as in the above experiments is given in Table II; the texture was grey. In some cases nickel was added in order to examine the effect of this component on the growth. The bars,

TABLE I.—*In percentages.*

Sample No.	Total Carbon untreated.	Total Carbon after treatment	Graphite untreated.	Graphite after treatment.	Si	Mn	P	S
1.—I	2.84	2.81	—	2.02	0.83	1.10	0.11	0.07
II	—	2.80	—	2.02	—	—	—	—
III	—	2.84	—	2.01	—	—	—	—
2.—I	2.93	2.97	2.14	2.17	1.08	1.16	0.08	0.056
II	—	2.98	—	2.19	—	—	—	—
III	—	2.92	—	2.19	—	—	—	—
3.—I	2.68	2.65	1.79	1.84	1.39	1.18	0.09	0.07
II	—	2.67	—	1.82	—	—	—	—
III	—	2.65	—	2.06	—	—	—	—
4.—I	3.20	3.10	2.30	2.31	1.59	1.02	0.20	0.064
5.—I	3.10	3.09	2.29	2.27	1.90	1.02	0.19	0.066
6.—I	3.20	3.14	2.68	2.62	2.30	0.48	0.81	0.082
II	—	3.10	—	2.65	—	—	—	—
III	—	3.12	—	2.58	—	—	—	—
7.—I	2.37	2.32	1.49	1.54	2.50	1.18	0.06	0.054
8.—I	1.96	1.95	1.20	1.22	2.83	1.10	0.04	0.052
II	—	1.93	—	1.23	—	—	—	—
III	—	1.92	—	1.19	—	—	—	—

I = 1st layer, ½-mm. thick. II = 2nd layer, ½-mm. thick. III = 3rd layer, ½ mm. thick.

must be concluded that the effect of silicon on the growth of cast iron is greater than that of carbon. Fig. 2 shows the relationship between the change of length and the silicon content. The tendency is the same as above, with the exception of the bars No. 7 and No. 8, which may be explained by the very low carbon content. A relationship between the change of length and the carbon content does not exist but when the carbon content is normal (bars 1, 2, 4, 5, 6), as the ends of which were protected against oxidation by means of caps, were subjected to the following treatment: heating for six hours at 600, 700, 800, 900 and 1,000 deg. C., and at last at 900 deg. C. for 4 × 4 hours. Three series of experiments were carried on: Series I and II in an electric furnace with supply of air; series III in a gas-fired muffle furnace. After the treatment the increase of length was measured and the texture examined. In Fig. 4 there are recorded the changes of length with respect to the silicon content, the carbon content, and the sili-

* Giesserei Zeitung, 1927, Nos. 9, 10.

con + carbon content respectively. The first curve shows that the changes of length follow, in

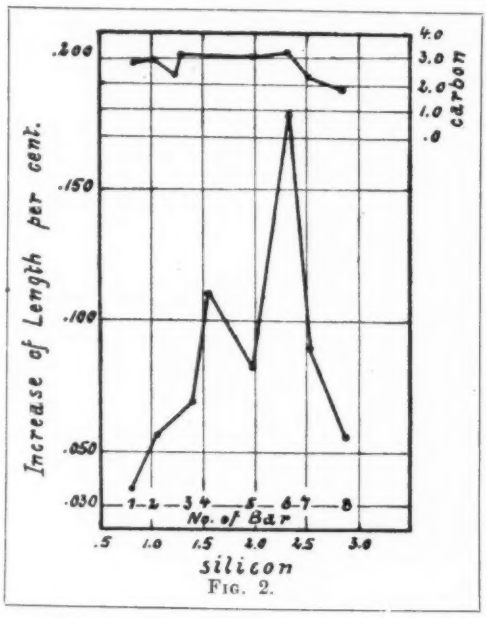


FIG. 2.

general, the silicon content with the exception of the bars II 2, III 1, II 1 and III 3. Nickel has no marked influence on the growth, a fact which is not in accordance with the general opinion. The second curve follows no particular law. Bar No. III 3 comes last, but has the same increase of length as the bar III 2, the carbon content of which is higher by 1.0 per cent. This proves that silicon affects the growth of cast iron to a higher degree than carbon, a fact which has already been shown by the experiments with superheated steam. The third curve is more regular. The bars III 2 and III 3 stand side by side. This indicates that a very low carbon content and a high silicon content exert the same influence as a medium silicon content and a normal carbon content. The micrographic examination showed that the heating at 600 deg. C. does not bring about any marked change of the graphite. By the heatings at higher temperatures the graphite flakes are enlarged and broken up. At the same time, the matrix gradually changes to pearlite, which, especially near the edge, is destroyed at higher temperatures. Experiments with hardening boxes containing a varying amount of carbon and silicon also showed that the growth of the iron follows the silicon values as well as that of silicon + carbon.

(*c*) Fire bars which had been destroyed in normal service were examined chemically and microscopically. The composition of the bars is given in Table III. In order to measure the temperature which might prevail on the fire side a hole was drilled from the bottom of a bar upwards to the surface and furnished with a thermo-couple. Temperatures of 1,000 to 1,100 deg. C. were measured. Therefore it may be expected that on the fire side of the bar the melting point

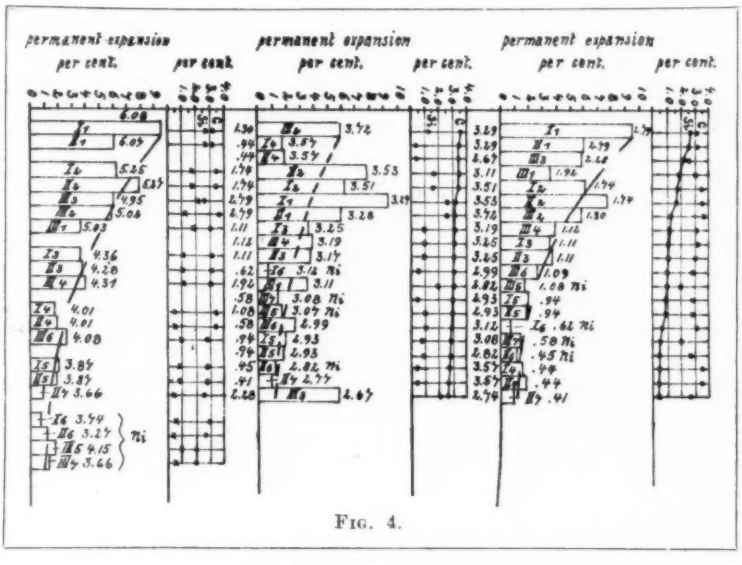


FIG. 4.

TABLE II.—*In percentages.*

Sample No.	C	Si	Mn	P	S	C+Si	Ni
			Series I.				
1	3.28	2.79	0.56	1.19	0.084	6.07	—
2	3.53	1.74	0.66	0.50	0.076	5.27	—
3	3.20	1.11	0.79	0.40	0.154	4.31	—
4	3.57	0.44	0.08	—	0.014	4.01	—
5	2.93	0.94	1.20	0.23	0.070	3.87	—
6	3.12	0.62	0.94	0.22	0.070	3.74	1.0
			Series II.				
1	3.28	2.79	0.56	1.19	0.084	6.07	—
2	3.53	1.74	0.66	0.50	0.076	5.27	—
3	3.20	1.11	0.79	0.40	0.154	4.31	—
4	3.57	0.44	0.08	—	0.014	4.01	—
5	2.93	0.94	1.20	0.23	0.070	3.87	—
6	2.82	0.45	0.87	0.14	0.041	3.27	1.07
7	2.74	0.41	0.71	0.07	0.082	3.15	—
			Series III.				
1	3.11	1.92	1.05	0.25	0.060	5.03	—
2	3.72	1.30	1.22	0.06	0.036	5.02	—
3	2.67	2.28	0.97	0.23	0.072	4.95	—
4	3.19	1.12	0.83	0.27	0.140	4.31	—
5	3.07	1.08	1.20	0.09	0.070	4.15	0.78
6	2.99	1.09	—	—	0.142	4.08	—
7	3.08	0.58	0.99	0.08	0.056	3.66	1.58

of cast iron is reached. The structural changes occur in distinct layers starting from the surface of the bar. As to the phosphorus, it was found that it does not emigrate from out the texture as it was observed by Kühnel.* The phosphorus content of the molten zone was the same as that of the original bar, though the phosphide network had disappeared. It seems that the phosphorus enters the mixed crystal. It was not except near the edge of the molten zone that a phosphide texture was observed; here, indeed, the phosphorus content was higher than in the original bar. Therefore the deleterious effect of the phosphorus is that in connection with the slag, it lowers the melting point of the iron. As to the sulphur, the observations made were the same as that by Kühnel. The increase of the sulphur content on the fire side was found to be up to 0.46 per cent. This layer, rich in sulphur, was of about 2 mm. of thickness; the next layer of 5 mm. of thickness showed a varying sulphur content; then the content was normal. The layer, rich in sulphur, scaled very easily. Bars which were kept in an atmosphere of SO_2, free from water, for 30 hours at a low red heat, showed a sulphur content of 3.54 per cent.

TABLE III.—*In percentages.*

Bar No.	Composition of the original bar.					Composition after service.				
	Si	S	C	Mn	P	Si	S	C	Mn	P
1A	2.36	0.134	3.25	0.37	0.97	2.46	0.142	3.18	0.39	0.99
B	—	—	—	—	—	2.40	0.148	3.17	—	—
C	—	—	—	—	—	2.41	0.138	3.18	—	—
2A	2.79	0.086	3.40	0.51	0.81	2.98	0.110	3.48	—	—
B	—	—	—	—	—	2.94	0.094	3.30	—	—
C	—	—	—	—	—	2.86	0.096	3.28	—	—
D	—	—	—	—	—	2.84	0.092	3.40	—	—
E	—	—	—	—	—	2.84	0.110	3.31	—	—

Company Meetings.

Midland Iron Company, Limited.—Lieut.-Col. H. Rhodes, presiding at the 28th annual meeting, on July 15, paid tribute to the memory of the late Mr. A. B. Baylis, formerly chairman and managing director, who, he said, was with the company for 49 years. Referring to the report and balance-sheet, he said that, considering the fact that the works were closed down for nearly seven months, they were rather to be congratulated that they were not worse off than they were. The bright spot seemed to have been that they were able to keep the brickworks going during the stoppage. The building trade did not seem to be affected, but he thought that the brick boom was now over. Although they were doing well with the brickworks, he thought that the proposal made some time ago to extend them could not be considered. The effect of foreign competition on their company had been that before the war they had 21 puddling furnaces and three ball furnaces, but to-day they were able to keep going only four puddling and two ball furnaces.

Robert Heath & Low Moor, Limited.—The annual meeting was held in London on July 13. Mr. Arthur Colegate, chairman of the company, presided, and, in moving the adoption of the report and accounts, said that the position of the company was dealt with very fully at the recent meeting of debenture-holders. Comparing the balance-sheet with that of the previous year, the alterations were not very material, except in one particular. The debentures were rather over £9,000 less in nominal value than they were a year ago, owing to the operation of the redemption fund. The profit and loss account showed that during the very difficult period under review a trading profit of £8,499 was earned, but when they deducted the debenture interest, £47,000, it gave a net loss of £38,000. Those results were naturally very disappointing, but what else could be expected in a year of such unparalleled and unprecedented depression in the coal, iron and steel trades as 1926? In some ways it was surprising that there should be a trading profit at all, because many similar companies had an actual loss even apart from their debenture interest. The present position in the iron and coal trade was still exceedingly bad. There was a leading article in "The Times" that day which set out very clearly what the result of the strike had been in the export markets and internal trade, and he could not add anything to that statement of the position. In regard to future prospects, he could only say that they were endeavouring very hard to hold their own in exceedingly difficult circumstances.

* See Foundry Trade Journal.

Foundry Statistics.

During April the American pig-iron exports reached 3,753 tons, whilst 8,923 tons were imported. Last year the corresponding figures were 2,010 and 54,359 tons. Cast-iron pipe exports were less in April at 1,644 by 858 tons as compared with 1926, whilst the imports were decidedly heavier at 8,738 tons, an increase of practically 3,700 tons over the previous April. These figures are true representation of the increased business in this foundry product, as during the last 10 months, dating from April, 88,479 tons have entered the U.S.A.—whereas the corresponding period of 1925-6 the total reached 48,168.

In May France exported 85,844 of pig-iron, and imported 3,978 metric tons. Castings to the extent of 30,455 tons were exported, and only 128 metric tons imported. During this month Germany imported 23,082 and exported 40,073 metric tons of pig-iron. The business in castings was 7,498 tons imported and 18,749 exported.

The May figures for Belgium are 27,843 metric tons of pig-iron imported, and 10,766 exported, whilst of castings 426 tons came into the country and 4,406 left. Of these quantities 3 tons came from England and 1,197 were sent to us.

Imports of pig-iron in Sweden have for the first six months of this year been heavier than for the corresponding period of 1926, 14,000 tons odd, and stood at 35,812 tons. A similar increase in cast-iron pipe is shown, which reached 7,347 tons. The improved condition of the German steel foundry business is reflected in their June figures. The weight of castings made from basic steel was 15,504; from acid steel 8,158, and 1,320 tons from crucible and electric. The corresponding figures last year were 9,512, 5,072 and 761.

Personal.

Mr. F. G. Whipp, previously with Fricker's Metal Company, Limited, has been appointed engineer and manager to C. J. Worsley, Melson Street, Luton.

Mr. Ridley Dixon, who has been with Messrs. N. Hingley & Sons, Limited, since the war, and who formed and managed for them the Netherton Coal Company and subsequently was managing director of Sterling Coal & Supplies, Limited, from its inception, has now joined the staff of Messrs. Lunt Brothers, of 13, Colmore Row, Birmingham.

Wills.

Hickman, J. B., of Parkholme, Cradley, Worcestershire, chairman of Sheet Iron Works, Limited £7,040

Thompson, J. L., of Sunderland, chairman of Robb Thompson & Sons, Limited, shipbuilders £117,016

Contracts Open.

Melbourne, November 14.—(27/58) One 40-ton electrically-operated travelling crane, for the State Electricity Commission of Victoria, for the Yallourn Brown coal scheme, Victoria, Australia. The Agent-General for Victoria, Victoria House, The Strand, London, E.C.2. (Fee £5 5s. for four copies of tender form, etc., returnable; extra copies £1 11s. 6d. each, non-returnable; preliminary deposit of £100 to be lodged with tender.)

Wellington, N.Z., November 24.—One electrically operated level luffing crane, for the New Zealand Government Railways. The Department of Overseas Trade, 35, Old Queen Street, S.W.1. (Ref. A.X.

C. H. Clarke & Company have removed to 15a, Liverpool Road, Deansgate, Manchester.

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Trade Talk.

Blackstone & Company, Limited, Stamford, have been successful with their tender for £3,241 for the supply and erection of electric generating plant for the Armagh Town Council.

Swan, Hunter & Wigham Richardson, Limited, of Wallsend-on-Tyne, have booked an order for a vessel of 3,700 tons for Norwegian owners. The vessel will be built at the firm's Sunderland yard.

The Integra Company, Limited, 183, Broad Street, Birmingham, are British agents for the Hump electric hardening furnace and the Homo electric tempering furnace, both specialities of the Leeds & Northrup Company, Philadelphia, U.S.A.

Davey, Paxman & Company, Limited, Colchester, have purchased the West Hydraulic Engineering Company, Limited, of Luton, which has now been transferred to Colchester, where the manufacture of the latter company's hydraulic specialities will be continued.

Clayton & Shuttleworth, Limited, Lincoln, are supplying complete power-house equipment for the Electric Supply Company, Brightlingsea, comprising 150 and 30 B.H.P. cold starting oil engines, coupled to alternators with switchboard, 5-ton overhead crane, compressors, pump, etc.

In celebration of the jubilee of the firm of Hawkins & Company, Crown Foundry, Dudley Port, Tipton, the workmen have been each presented with 50s. and the juvenile employees with 25s. each. In addition, all the workmen and staff spent a day at Blackpool at the invitation of their employers.

Mr. S. Twentyman Coulson, chairman of Richardsons, Westgarth & Company, Limited, has concluded an agreement with Brown, Boveri & Company, of Baden, Switzerland, which gives Messrs. Richardsons Westgarth the exclusive right to manufacture in Great Britain and Ireland steam turbines and electric generators, etc., according to Brown Boveri's patents.

John Thompson Water Tube Boilers, Limited, Imperial House, Kingsway, London, W.C.2, have received an order from the Metropolitan Asylums Board for one of their horizontal tube staggered header "Zeta" type water tube boilers, complete with chain grate stoker, feed pumps, condensate tank, brickwork, pipework, etc., to be erected at Dartford, Kent.

It is gratifying to record that, despite the present trade depression and severe Continental competition, the demand for the specialities of the Ransome & Marles Bearing Company, Limited, continues to increase. The company's works at Newark-on-Trent have been greatly extended to cope with these requirements, and even now further extensions are in progress. The present monthly output exceeds the total four years' war output.

Intimation has been made to Messrs. J. C. Bishop and O. Coyle, joint secretaries of the Board of Conciliation for the Regulation of Wages in the Pig-iron Trade of Scotland, by the accountants, to the effect that they have examined the employers' books for April, May, and June, 1927, and have certified that the average net selling price is £4 3s. This means that there will be a decrease in the wages of the workmen of 2 per cent. on basic rates.

The Société Anonyme-Mines de Fer de Rouina (Algeria) report that the company's mines produced the following quantities of iron ore during 1926:—Rouina division, 152,818 tons; Bréira division, 65,417 tons; Philippeville division, 25,843 tons; total, 244,078 tons. In addition to this the Rouina works produced 36,077 tons of iron-ore briquettes, and the affiliated Société des Mines de Fer de Miliana mined 30,229 tons of iron ore. The iron ore shipments of the Rouina Company only totalled 159,111 tons during last year, and the Miliana Company 20,052 tons.

The secretary of Irvine's Shipbuilding and Dry Docks Company, Limited, has stated that the circular dated July 14, sent by Mr. W. H. Loveridge, managing director of the North-East Salvage and Shipbreaking Company, Limited, to the shareholders of Irvine's has not been issued with the concurrence or approval of the board of management of Irvine's, and that they disclaim any knowledge whatever of the proposal referred to. The circular referred to states: "It is proposed to register a company of £250,000 for the following purposes: To absorb the North-East Salvage and Shipbreaking Company, Limited, and to provide increased capital for its business of shipbreaking and salvage, and to provide for the construction of two steamers each of 6,500 tons. In doing the latter, it affords an opportunity (if the capital is forthcoming) for the reopening of the shipyard of Irvine's Shipbuilding and Dry Docks Company, Limited, in which I am interested, and you are asked as shareholders of that company to give this proposal your favourable consideration and to intimate any promise of subscription to the shares of 'Nessco, Limited,' when formally created."

Company Reports.

Mather & Platt, Limited.—Interim dividend, 5 per cent. on ordinary shares, free of tax.

Herbert Morris, Limited.—Dividend for half-year on 6 per cent. (less tax) and 5 per cent. (free of tax) cumulative preference shares.

Thomas Bolton & Sons, Limited.—Dividend, 2½ per cent. for year; £15,000 transferred from reserve to profit and loss; £2,332 forward.

A. & J. Main, Limited.—Profit, £17,465; brought forward, £4,745; total, £22,210; depreciation, £2,200; dividend, 6½ per cent., less tax, on preference shares, £4,408; dividend, 10 per cent., less tax, on ordinary shares, £6,224; reserve account, £5,000; carried forward, £4,378.

Warner & Company, Limited.—Profit, £11,145; appreciation in value of investments, £263; amount brought in, £3,057; final dividend on ordinary, 15 per cent., less tax, making 17½ per cent., less tax, for year; depreciation (property, plant, etc.), £1,000; forward, £2,730.

Bengal Iron Company, Limited.—Profit, including £128,456 due from Indian Iron and Steel Company, Limited, £291,644; debit balance brought forward, £96,072; balance, £195,571; depreciation and colliery sinking fund, £46,456; debenture interest, £67,933; debenture redemption sinking fund, £22,066; amount written off debenture discount account, £4,550; taxation reserve, £10,000; preference share dividend for year 1926, £37,500; carried forward, £7,065. During last year two blast furnaces were restarted by the Bengal Iron Company, Limited. Should the demand warrant it, another furnace will be put in blast, probably before the end of the current financial year, when the improvements now being made to it are completed. Mr. H. P. Martin, representing the Indian Iron and Steel Company, Limited, has been elected a director of the company in place of Mr. C. B. Chartres, the latter gentleman having been elected to a seat on the board as an ordinary director. Col. Sir W. Charles Wright, Bart., has also been elected a director of the company.

New Companies.

Bradshaw & Company (Accrington), Limited, Clement Street, Accrington.—Capital £3,000. Engineers, iron and brass founders, etc. Permanent directors: F. Bradshaw and R. Bradshaw.

James Carmichael & Company (Engineers), Limited, 37, Renfield Street, Glasgow.—Capital £60,000 in £1 shares, to acquire business of James Carmichael & Company, Limited, Ward Foundry, Dundee, and Dundee Steam Forge. Directors: J. MacLeod, 118, Stranmore Road, Mount Florida, Glasgow; H. S. S. Murray, Rocknowe, Dundee; R. H. Brown, Montraive, Grove Park, London, S.E.12; and J. Gordon, 1A, Cavendish Road, St. John's Wood, London, N.W.8. Secretary: John R. Renwick.

William Geipel, Limited, Vulcan Works, 156-170, Bermondsey Street, S.E.1.—Capital £25,150 in 25,000 5 per cent. preference, 100 ordinary "A," and 50 ordinary "B" shares of £1. Machinery manufacturers. Directors: W. Goy-Pell and K. S. Geipel.

Ricardo & Company, Engineers, Limited, 21, Suffolk Street, Pall Mall, S.W.1.—Capital £21,000 in 20,000 10 per cent. cumulative participating preference shares of £1 and 20,000 founders' shares of 1s. Electrical and mechanical engineers, etc. Directors: A. A. C. Swinton, S. A. de la Rue, S. F. Staples, and others.

P. E. Robins, Limited, Bassishaw House, Basinghall Street, E.C.2.—Capital £5,000 in £1 shares. Tinplate merchants.

Stainless Hollowware & Tube Company (Sheffield), Limited, 61, Norfolk Street, Sheffield.—Capital £1,500 in £1 shares. Directors: E. Holmes, F. M. Moody and J. McKane.

Thames Tube & Fittings Company (Great Britain), Limited.—Capital £25,000 in £1 shares. Directors: C. G. A. Acheson-Gray, 29, Mincing Lane, E.C.; E. L. F. Archdeacon, 35, Cambridge Street, W.2; and R. H. Ferguson, Bilbao House, New Broad Street, E.C.

William Wilson & Company (Aberdeen), Limited, —Capital £20,000 in £1 shares. Tinplate merchants. Directors: J. L. Philip, 71, Ashley Road, Aberdeen; J. M. Dunn, 3, West Crailstone Street, Aberdeen; and G. G. Wilson, Aberdeen.

Obituary.

Mr. F. Joslin, one of the directors of the Borough Engineering Works, Limited, Ashton Road, Luton, died recently at the age of 66.

Mr. J. Hobson, of Woodbank Crescent, works manager for over 36 years with the Hardy Patent Pick Company, Limited, died last week.

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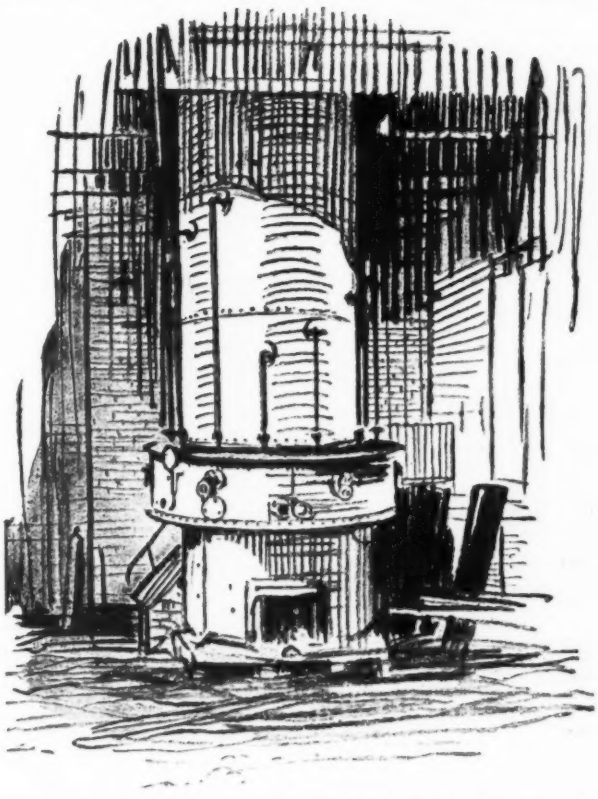

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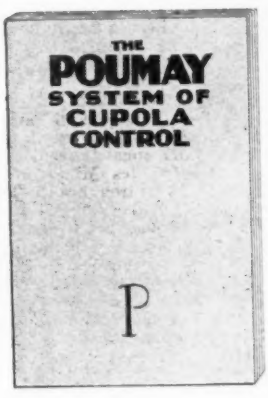

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IRON AND STEEL MARKETS.

Pig-iron.

MIDDLESBROUGH.—Suspended during the current week on holiday account, business in the Cleveland iron market can hardly be said to be much affected, transactions for some time past having been almost negligible in volume, with conditions, it must be regretfully admitted, unlikely to improve to any measureable extent before the autumn is well advanced. The position assumed by consumers at the moment may be briefly stated as directly antagonistic to the attitude of the ironmasters on the question of prices, the first-named contending that the present costs of production no longer justify the high levels maintained by makers, while the latter firmly adhere to quotations precluding any possibility of an early expansion of demand. Consequently buying on any scale of magnitude has almost entirely ceased, consumers holding off the market or else obtaining supplies elsewhere. As indicated above, there has been no change in prices, makers' minimum quotations being:—No. 1 Cleveland foundry iron, 72s. 6d. per ton; No. 3 Cleveland G.M.B., 70s.; No. 4 foundry, 69s.; No. 4 forge, 68s. 6d. per ton.

Although a substantial reduction of the output of hematite in the Tees-side area has been recently effected, existing demand is still in excess of production, and makers are quite prepared to cut current prices of 76s. per ton for East Coast mixed numbers to secure business. On the North-West Coast Bessemer mixed numbers are quoted nominally at £4 6s. per ton delivered at Glasgow, £4 10s. per ton delivered at Manchester, £4 12s. 6d. per ton delivered at Sheffield, and £4 13s. 9d. per ton delivered at Birmingham.

LANCASHIRE.—So far as prices are concerned, there has been no change to note in local markets for foundry pig. Staffordshire iron has been offering at round 76s. per ton, delivered Manchester or equal distance, with Derbyshire brands quoted at from 75s. 6d. to 76s., Cleveland at 83s. 2d., and Scottish at 95s.

THE MIDLANDS.—Most of the ironfounders in this area have suspended deliveries from furnaces for a week or two, and consumers generally are by no means eager buyers. It is reported that under 62s. 6d. has been taken by certain Northamptonshire furnaces, but several of the makers are holding firm for 62s. 6d. at the furnaces. With regard to Derbyshire, nothing less than 67s. 6d. is being offered, and No. 3 Staffordshire is on the same level.

SCOTLAND.—Following the Glasgow Fair holidays, there has been very little business put through in the pig-iron market, and prices are again easier on the basis of 77s. f.o.t. furnaces for No. 3 Scotch foundry.

Finished Iron.

Bar-iron works are still very short of orders for all grades, but particularly crown, nut and bolt and fencing. There is a considerable amount of price-cutting for crown quality. These bars can be purchased from £9 15s. up to £10 5s., according to the nature of the order, and second quality at about 10s. per ton less. What business there is now for nut and bolt iron is going abroad, because of the disparity between the two prices. No change has taken place in the price of marked bars, which remains at £13 10s. at makers' works. The works making this grade of iron are only moderately busy, and are anything but satisfied with the present position.

Steel.

Following the reduction in the prices of acid and basic billets, the Wire Rod Rollers' Association has reduced the official minimum quotations for acid rods by 20s. per ton, and for hard basic rods by half that sum. The price of soft basic rods is not controlled, and remains at about £9 5s. per ton. There is not much doing in billets, either acid or basic, but the approach of the holiday is mainly responsible for this. The output of open-hearth steel is being increased again in this area by the relighting of furnaces. Exports of the cheaper steels are on a smaller scale, but the general condition of the steel trade is not discouraging when everything is taken into account. The home trade in tinplates is as dull as possible, with rates easy at 18s. 6d. basis for coke primes, and 17s. basis for wasters in regular sizes, net cash, f.o.t. at makers' works.

Scrap.

The depression in the iron and steel scrap markets is still profound, and any price changes which have occurred have been in a downward direction. At the same time, the bear movement is being strenuously resisted by merchants, and as most of them have good contracts running at prices well above those now offered, they are not inclined to release much material. There are still a few openings in the Tees-side market for the disposal of heavy steel turnings and cast-iron borings, but the former are a trifle easier at 44s. per ton, with cast-iron borings steady at 42s. 6d. The local foundries are buying very little heavy cast iron of any description. In the absence of buyers, ordinary quality has declined from 62s. 6d. to 61s. 6d. per ton, and although machinery quality is nominally unchanged at 67s. 6d. per ton, business might be possible at 65s., all quotations being delivered works.

Metals.

Copper.—Movements in the markets for basic metals during the past week have disclosed a steady tendency, and in standard copper especially a distinctly stronger tone was noted as regards spot transactions. In the later dealings, however, prices eased from the best owing to profit taking, but the undertone continues steady, with a net improvement amounting to quite a substantial sum considering recent conditions.

Official closing prices of standard copper have been as follow:—

Cash: Thursday, £55 15s. to £55 16s. 3d.; Friday, £56 to £56 1s. 3d.; Tuesday, £56 5s. to £56 6s. 3d.; Wednesday, £56 8s. 9d. to £56 10s.

Three Months: Thursday, £55 18s. 9d. to £56; Friday, £56 5s. to £56 6s. 3d.; Tuesday, £56 10s. to £56 11s. 3d.; Wednesday, £56 16s. 3d. to £56 17s. 6d.

Tin.—The market for standard tin towards the close last week was subject to adverse influences, and under pressure of a poor demand values developed further weakness. Cash metal fell about £5, and the three months' price came down more or less in sympathy to the extent of about £2. The "backwardation" on the latter position, which temporarily increased to about £9, has been latterly reduced to close on £5 per ton. The speculative position has thus been eased to that extent.

Official closing prices of standard tin have been as under:—

Cash: Thursday, £289 to £289 5s.; Friday, £292 to £292 5s.; Tuesday, £298 to £298 5s.; Wednesday, £297 10s. to £297 15s.

Three Months: Thursday, £284 15s. to £284 17s. 6d.; Friday, £287 5s. to £287 10s.; Tuesday, £289 10s. to £289 15s.; Wednesday, £289 10s. to £289 15s.

Spelter.—The movement in ordinary spelter, which has lately gained considerable strength, has been more due to sympathy with the rise in other metals than to any sustained demand for the metal. Actually this movement has not brought out much consumptive interest, as the demand is not there at the moment.

The following are the week's prices:—

Ordinary: Thursday, £29 5s.; Friday, £29 10s.; Tuesday, £29 6s. 3d.; Wednesday, £29 7s. 6d.

Lead.—An upward tendency in values in soft foreign pig has also to be recorded, and a fairly substantial one at that, considering recent conditions. The rise was initiated by the American market, and this caused speculators over here to become more interested and to buy rather liberally.

The week's prices are appended:—

Soft foreign (prompt): Thursday, £24 2s. 6d.; Friday, £24 7s. 6d.; Tuesday, £24 8s. 9d.; Wednesday, £24 6s. 3d.

Death of Mr Alexander Jack.

We regret to announce the death of Mr. Alexander M. Jack, who retired six years ago after having risen from an apprentice to be deputy chairman of Hadfields, Limited, of Sheffield, the well-known steel founding firm. The deceased gentleman was a magistrate, and formerly a City Councillor.

Mr. Jack's industrial career began at the age of twelve. He became an engineer in the United States Navy, and at the age of 24 years was responsible for the erection of an arsenal near Tientsin, North China. He could both write and speak Chinese fluently. He was associated with Hadfields, Limited, for 33 years, helped to establish the 48 hours week, and became successively works manager, general manager, managing director, and, finally, deputy chairman. When he retired Sir Robert Hadfield described him as having been a tower of strength to the firm commercially and technically.

BLACKING,
PLUMBAGO,
CORE GUM,
WHITE DUST,
COAL DUST.

ESTABLISHED 1863

JAS. DURRANS & SONS, LTD.

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CORE ROPES.
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Write for Illustrated Catalogue on Blacking and Foundry Requisites, also for our latest Price List.

PIG IRON
and
High Grade
CYLINDER
IRON
For Motor Castings.

FOUNDRY & FURNACE COKE

J. C. ABBOTT & Co LTD

LLOYD'S BANK CHAMBERS, NEW STREET, BIRMINGHAM.
TELEPHONE: MIDLAND 170.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	56	8	9
Three months	56	16	3
Electrolytic	62	15	0
Tough	59	10	0
Best selected	60	10	0
Sheets	84	0	0
India	69	15	0
Wire bars	62	10	0
Do. September	62	6	3
Do. October	62	6	3
Ingot bars	62	6	3
H.C. wire rods	66	15	0
Off. av. cash, July	54	11	8 5/24
Do. 3 mths. July	54	19	9½
Do., Sttlmnt. July	54	11	6½
Do., Electro, July	60	6	6½
Do., B.S., July	58	15	3½
Aver. spot price copper, July	54	11	8¼
Do., wire bars, July	60	11	3¾
Solid drawn tubes			12¼d.
Brazed tubes			12½d.
Wire			9½d.

BRASS.

Solid drawn tubes	11¼d.
Brazed tubes	13¼d.
Rods, drawn	10½d.
Rods, extd. or rlld.	7½d.
Sheets to 10 w.g.	9⅝d.
Wire	9½d.
Rolled metal	9¼d.
Yellow metal rods	7½d.
Do. 4 × 4 Squares	8d.
Do. 4 × 3 Sheets	8½d.

TIN.

	£	s.	d.
Standard cash	297	10	0
Three months	289	10	0
English	295	5	0
Bars	298	0	0
Straits	304	0	0
Australian	304	0	0
Eastern	296	10	0
Banca	312	0	0
Off.avr.cash, July	288	16	3
Do., 3 mths., July	281	19	3½
Do., Sttlmt. July	288	15	11½
Aver. spot, July	288	16	3

SPELTER.

	£	s.	d.
Ordinary	29	7	6
Remelted	27	0	0
Hard	23	0	0
Electro 99.9	32	5	0
English	30	0	0
India	25	0	0
Zinc dust	37	0	0
Zinc ashes	10	10	0
Off. aver., July	28	3	0 1/16
Aver., spot, July	28	5	7

LEAD.

	£	s.	d.
Soft foreign ppt.	24	6	3
English	25	10	0
Off. average, July	23	14	2½
Average spot, July	23	9	9¾

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	36	0	0
Do. V.M. ex whf.	34	10	0
Rods	42	0	0
Boiler plates	34	0	0
Battery plates	33	10	0

ANTIMONY.

	£	s.	d.
Special brands, Eng.	67	0	0
Chinese	52	0	0
Crude	37	0	0

QUICKSILVER.

	£	s.	d.
Quicksilver	21	15	0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
25%	£8 15 0
45/50%	£12 10 0
75%	£19 15 0
Ferro-vanadium—	
35/40%	£14/3 lb. va.
Ferro-molybdenum—	
70/75% c. free	5/- lb.
Ferro-titanium—	
23/25% carbonless	11¼d.
Ferro-phosphorus, 20/25%,	£17 15 0
Ferro-tungsten—	
80/85%, c. fr.	1/4 lb.
Tungsten metal powder—	
98/99%	1/8½ lb.
Ferro-chrome	
2/4% car.	£33 15 0
4/6% car.	£23 15 0
6/8% car.	£23 0 0
8/10% car.	£22 12 6
Ferro-chrome—	
Max. 2% car.	£36 0 0
Max. 1% car.	£42 0 0
Max.0.70% car.	£54 0 0
70%, carbonless	1/5 lb.
Nickel—99%, cubes or pellets	£170
Ferro-cobalt	9/3 lb.
Aluminium 98/99%	£105
Metallic chromium—	
96/98%	3/3 lb.
Ferro-manganese (net)—	
76/80%, loose	£12 0 0
76/80%, packed	£13 0 0
76/80%, export	£11 15 0
Metallic manganese—	
94/96%, carbonless	1/10 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

	s.	d.
Finished bars, 14% tungsten	2	6
Finished bars, 18% tungsten	3	0

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares 3 in. and over	4d. lb.
Rounds and squares under ¼ in. to ¼ in.	3d. lb.
Do., under ¼ in. to ⅛ in.	1/- lb.
Flats, ¼ in. × ¼ in. to under 1 in. × ⅛ in.	3d. lb.
Do. under ¼in. × ¼in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.
Bars cut to length	10% extra.

Scrap from high-speed tool steel—

Scrap pieces	3d.
Turnings and swarf	1d.

Per lb. net, d/d steel makers' works.

SCRAP.

	£	s.	d.		£	s.	d.
South Wales—							
Hvy. steel	3	0	0	to	3	2	6
Bundled steel & shrngs.	2	12	6	to	2	14	0
Mixed iron & steel			2	15	0		
Heavy cast iron	3	0	0	to	3	2	6
Good machinery for foundries	3	1	0	to	3	2	6
Cleveland—							
Heavy steel	2	15	0	to	2	17	6
Steel turnings			2	4	0		
Cast iron borings			2	2	6		
Heavy forge			3	12	6		
Bushelled scrap			3	2	6		
Cast-iron scrap	3	1	6	to	3	7	6
Lancashire—							
Cast-iron scrap			3	7	6		
Hvy. wrought			3	2	6		
Steel turnings			2	2	6		
London — Merchants' buying prices delivered yard.							
Copper (clean)			50	0	0		
Brass (clean)			38	0	0		
Lead (less usual draft)			21	0	0		
Tea lead			18	0	0		
Zinc			18	0	0		
New aluminium cuttings			80	0	0		
Braziery copper			45	0	0		
Gunmetal			47	0	0		
Hollow pewter			170	0	0		
Shaped black pewter			130	0	0		

PIG-IRON

(f.o.t. unless otherwise stated).

N.E. Coast—	
Foundry No. 1	72/6
Foundry No. 3	70/-
Foundry No. 4	69/-
Forge No. 4	68/6
Hematite No. 1	76/6
Hematite M/Nos.	76/-
N.W. Coast—	
Hem. M/Nos. d/d Glas.	86/-
,, d/d Birm.	93/9
Midlands—	
Staffs. common*	—
,, No. 4 forge	—
,, No. 3 fdry.	67/6
Shrops. basic	—
,, Cold blast, ord.*	—
,, ,, roll iron*	—
* d/d Birmingham.	
Northants forge	—
,, fdry. No. 3	62/6
Derbyshire forge	—
,, fdry. No. 3	67/6
,, basic	—
Scotland—	
Foundry No. 1	—
,, No. 3	77/-
Hem. M/Nos.	78/6
Sheffield (d/d district)—	
Derby forge	67/6
,, fdry. No. 3	70/-
Lincs. forge	—
,, fdry. No. 3	72/6
E.C. hematite	88/6
W.C. hematite	92/6
Lincs. (at furnaces)—	
Forge No. 4	—
Foundry No. 3	—
Basic	—
Lancashire (d/d eq. Man.)—	
Derby forge	—
,, fdry. No. 3	77/-
Northants foundry No. 3	—
Dalzell, No. 3	105/- to 109/-
Summerlee, No. 3	95/-to101/-
Glengarnock, No.3	95/-to101/-
Gartsherrie, No.3	95/- to 101/-
Monkland, No.3	95/- to 101/-
Coltness, No. 3	95/- to 101/-
Shotts, No. 3	95/- to 101/-

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.		£	s.	d.
Bars (cr.) nom.	9	15	0	to	11	0	0
Angles			—				
Tees to 3 united ins.			—				
Nut and bolt iron			—				
Hoops			14	10	0		
Marked bars (Staffs.) f.o.t.			13	10	0		
Gas strip			12	10	0		
Bolts and nuts ⅞ in. × 4 in.			15	5	0		
Steel—							
Ship plates	8	2	6	to	8	7	6
Boiler plts.			11	0	0		
Chequer plts.			10	5	0		
Angles			7	12	6		
Tees			8	12	6		
Joists			7	12	6		
Rounds and squares 3 in. to 5½ ins.			7	15	0		
Rounds under 3 in. to ⅜ in. (Untested)	8	0	0	and upwards			
Flats, over 5 in. wide and up			9	2	6		
Flats, 5in. to 1½in.	8	2	6				
Rails, heavy			8	2	6		
Fishplates			12	10	0		
Hoops (Staffs.)			10	10	0		
Black sheets, 24g.	10	7	6				
Galv. cor. shts, 24g.	14	0	0				
Galv. fencing wire 8g. plain			12	10	0		
Billets, soft	6	10	0	to	7	0	0
Billets, hard			8	2	6		
Sheet bars			5	15	0		
Tin bars d/d			5	15	0		

PHOSPHOR BRONZE.

	Per lb.	basis.
Strip	1	2¼
Sheet to 10 w.g.	1	2¾
Wire	1	3¼
Rods	1	2¾
Tubes	1	8
Castings	1	2

Delivery 3 cwt. free.

10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	per lb.
Ingots for raising	9d. to 1/3
Rolled—	
To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3½ to 1/9½
To 15 in. wide	1/3½ to 1/9½
To 18 in. wide	1/4 to 1/10
To 21 in. wide	1/4½ to 1/10½
To 25 in. wide	1/5 to 1/11
Ingots for spoons and forks	9d. to 1/5½
Ingots rolled to spoon size	1/- to 1/8½
Wire round—	
3/0 to 10 G.	1/6½ to 2/1½

with extras according to gauge.

AMERICAN IRON & STEEL

At Pittsburgh unless otherwise stated.	Dols.
No. 2X foundry, Phila.	20.76
No. 2 foundry, Valley	18.00
No. 2 foundry, Birm.	17.25
Basic	20.75
Bessemer	20.26
Malleable	19.76
Grey forge	19.26
Ferro-mang. 80% d/d	90.00
Bess. rails, h'y, at mill	43.00
O.-h. rails, h'y at mill	43.00
Bess billets	33.00
O.-h. billets	33.00
O.-h. sheet bars	34.00
Wire rods	42.00
	Cents.
Iron bars, Phila.	2.12
Steel bars	1.80
Tank plates	1.80
Beams, etc.	1.80
Skelp, grooved steel	1.80
Skelp, sheared steel	1.80
Steel hoops	2.30
Sheets, black, No. 24	3.00
Sheets, galv., No. 24	3.85
Sheets, blue an'l'd, 9 & 10	2.25
Wire nails	2.55
Plain wire	2.40
Barbed wire, galv.	3.25
Tinplate, 100 lb. box	$5.50

COKE (at ovens).

Welsh foundry	—
,, furnace	—
Durham & North.	
,, foundry	—
,, furnace	15/-
Other Districts, foundry	—
,, ,, furnace (basis)	12/6

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. Cokes,	20×14, box	18/6
,,	28×20, ,,	37/-
,,	20×10, ,,	—
,,	18¾×14, ,,	—
C.W.	20×14, ,,	17/-
,,	28×20, ,,	—
,,	20×10, ,,	—
,,	18¾×14, ,,	—

Terneplates 28 × 20, — per box basis f.o.b.

SWEDISH IRON.

Bars, hammered	£18/10 to £19/0
Rolled Ord.	£15/5/0 to £15/15
Nail rods	£15 12 6 to £16 0 0
Keg. steel nom.	£33 to £35
Faggot steel nom.	£22 to £25
Blooms, according to quality	£8 to £12
Pig-iron all f.o.b. Gothenburg.	£6 0 0 to £6 10 0

TUBES AND FITTINGS.

Up to and incl. 6 in.

	Tubes.	*Fittings*
Gas	67½%	45%
Water	62½%	40%
Steam	57½%	35%

W.I. 10% extra.

DAILY FLUCTUATIONS.

Standard Copper (Cash).

	£	s.	d.	
July 28	55	15	0	inc. 5/–
„ 29	56	0	0	„ 5/–
Aug. 2	56	5	0	„ 5/–
„ 3	56	8	9	„ 3/9

Electrolytic Copper.

	£	s.	d.	
July 28	60	15	0	No change
„ 29	61	0	0	inc. 5/–
Aug. 2	62	0	0	„ 20/–
„ 3	62	15	0	„ 15/–

Standard Tin (Cash).

	£	s.	d.	
July 28	289	0	0	inc. 10/–
„ 29	292	0	0	„ 60/–
Aug. 2	298	0	0	„ 120/–
„ 3	297	10	0	dec. 10/–

Tin (English ingots).

	£	s.	d.	
July 28	286	10	0	No change
„ 29	290	0	0	inc. 70/–
Aug. 2	296	0	0	„ 120/–
„ 3	295	5	0	dec. 15/–

Zinc Sheets (English).

	£	s.	d.	
July 28	36	0	0	No change
„ 29	36	0	0	„ „
Aug. 2	36	0	0	„ „
„ 3	36	0	0	„ „

Spelter (ordinary).

	£	s.	d.	
July 28	29	5	0	inc. 5/–
„ 29	29	10	0	„ 5/–
Aug. 2	29	6	3	dec. 3/9
„ 3	29	7	6	inc. 1/3

Lead (English).

	£	s.	d.	
July 28	25	5	0	No change
„ 29	25	10	0	inc. 5/–
Aug. 2	25	10	0	No change
„ 3	25	10	0	„ „

AVERAGE PRICES OF GALVANISED CORRUGATED SHEETS (NORTH OF ENGLAND).

	Jan.			Feb.			March			April			May			June			July			Aug.			Sept.			Oct.			Nov.			Dec.			Yearly average		
	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
1901	13	0	0	12	5	0	11	10	0	11	16	0	11	10	0	11	10	0	11	10	0	11	10	0	12	0	0	12	0	0	12	0	0	12	0	0	11	17	1
1902	12	0	0	11	10	0	11	10	0	11	10	0	11	15	0	11	15	0	11	15	0	11	15	0	11	15	0	11	15	0	11	15	0	11	15	0	11	14	2
1903	11	5	0	11	5	0	11	5	0	11	10	0	11	10	0	11	10	0	11	10	0	11	10	0	11	5	0	11	5	0	11	5	0	11	5	0	11	7	1
1904	11	5	0	11	5	0	11	5	0	10	15	0	10	15	0	10	15	0	10	15	0	10	15	0	10	5	0	10	5	0	10	5	0	10	5	0	10	15	0
1905	10	7	6	10	7	6	10	7	6	10	7	6	10	7	6	10	7	6	10	7	6	11	0	0	11	5	0	11	15	0	12	0	0	10	15	0	10	15	0
1906	12	12	6	12	12	6	12	12	6	12	7	6	12	7	6	12	7	6	12	12	6	12	12	6	12	15	0	12	15	0	12	15	0	13	5	0	12	12	11½
1907	13	5	0	13	5	0	13	15	0	13	15	0	13	15	0	13	15	0	13	17	6	13	17	6	13	17	6	13	2	6	13	2	6	13	2	6	13	10	10
1908	13	2	6	12	10	0	12	10	0	12	10	0	12	10	0	12	10	0	12	10	0	12	10	0	12	10	0	12	10	0	12	10	0	12	10	0	12	11	0½
1909	12	10	0	12	10	0	12	10	0	12	10	0	12	10	0	12	10	0	12	10	0	10	10	0	11	0	0	11	0	0	11	0	0	11	0	0	11	16	8
1910	11	15	0	12	5	0	12	5	0	11	15	0	11	10	0	11	10	0	11	12	6	11	12	6	11	12	6	11	12	6	11	10	0	11	10	0	11	13	4
1911	11	5	0	11	1	3	10	15	0	10	15	0	10	13	9	10	10	0	10	13	9	11	0	0	11	5	0	11	5	0	11	5	0	11	7	0	10	19	7½
1912	11	10	0	11	10	0	11	10	0	11	15	0	12	5	0	12	5	0	12	5	0	12	5	0	12	5	0	12	12	6	12	18	0	12	15	0	12	2	11½
1913	12	15	0	12	15	0	12	15	0	12	11	3	11	18	0	11	15	0	11	15	0	11	15	0	11	15	0	11	3	0	11	0	0	11	2	6	11	18	4
1914	11	7	0	11	7	6	11	7	6	11	5	7½	11	2	6	10	15	0	10	15	0	12	17	6	14	2	0	13	7	0	11	15	7	11	2	6	11	16	0
1915	11	10	8½	13	12	6	14	8	9	15	0	6	17	17	6	20	17	6	20	17	6	20	6	3	17	12	6	18	1	0	22	13	9	25	2	0	18	3	4½
1916	26	5	0	27	12	6	28	0	0	28	5	0	29	0	0	29	0	0	28	15	0	28	3	0	28	15	0	28	15	0	28	15	0	28	15	0	28	6	8½
1917	28	15	0	28	15	0	28	15	0	28	15	0	28	15	0	28	15	0	28	15	0	28	15	0	28	15	0	28	15	0	28	0	0	28	0	0	28	11	3
1918	28	5	0	28	15	0	29	0	0	29	0	0	29	0	0	29	0	0	29	0	0	29	0	0	29	0	0	29	0	0	29	0	0	29	0	0	28	13	4
1919	29	0	0	29	0	0	29	0	0	28	0	0	28	10	0	27	7	6	27	5	0	29	3	0	32	0	0	33	0	0	36	10	0	40	8	4	31	5	3½
1920	46	10	0	49	15	0	53	15	0	56	0	0	55	10	0	54	10	0	52	10	0	48	10	0	44	3	4	39	2	6	35	17	6	30	8	0	47	4	3
1921	28	10	0	25	17	6	24	5	0	23	3	4	22	0	0	22	0	0	23	10	0	21	12	6	20	0	0	18	15	0	18	3	9	17	2	0	22	1	7
1922	16	17	6	15	13	9	16	3	0	16	10	0	16	4	4½	15	15	6	15	16	3	16	16	0	16	8	9	16	6	3	17	1	0	17	7	6	16	7	5½
1923	18	3	1½	19	1	11½	19	8	0	19	10	0	19	7	0	19	1	3	18	0	0	18	13	1½	19	0	0	19	3	9	19	2	6	18	19	4½	18	19	2
1924	18	13	6	18	9	4½	18	5	0	17	15	11½	17	3	0	17	19	4½	18	7	6	18	8	1½	18	8	1½	17	19	6	17	11	3	17	10	0	18	0	10½
1925	17	8	6	17	1	6½	16	9	4½	16	12	0	16	9	8¼	16	9	4½	16	0	6	16	1	10½	16	5	0	16	7	0	16	12	6	16	15	0	16	11	0½
1926	16	14	4½	16	5	7½	16	0	6	15	11	10½	15	11	3	16	0	0	16	16	0	16	18	9	16	14	0	16	18	9	17	10	0	16	19	0	16	10	0½
1927	16	3	1½	15	7	6	15	3	3	15	3	1½	14	14	4½	14	11	6	14	1	10½	—			—			—			—			—			8	15	4½

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PATENTS AND DESIGNS ACTS, 1907 and 1919.

NOTICE IS HEREBY GIVEN that Vacuumschmelze G.m.b.H., of 31, Gutleutstrasse, Frankfurt-on-the-Main, Germany, and Wilhelm Rohn, of 17, Grimmstrasse, Hanau-on-the-Main, Germany, seek leave to amend the Specification of Letters Patent No. 226,801 granted to them for an invention entitled "Process for the production and repair of refractory linings for hearths of metallurgical and other furnaces." Particulars of the proposed amendment were set forth in the Illustrated Official Journal (Patents), of the 27th July, 1927. Any person, or persons, may give Notice of Opposition to the amendment by leaving Patents Form No. 19 at the Patent Office, 25, Southampton Buildings, London, W.C.2., within one calendar month from the date of the said Journal.

W. S. Jarratt,
Comptroller-General.

MACHINERY.

GERMAN MANUFACTURERS.—Firms wishing to get into touch with makers of German goods should state their wishes to Box 802, c/o Hermann J. Fromm, Advertising Agency, Berlin, W.35, Lützowstr. 84. This information is provided for the use of buyers and not for individuals on the look-out for an agency.

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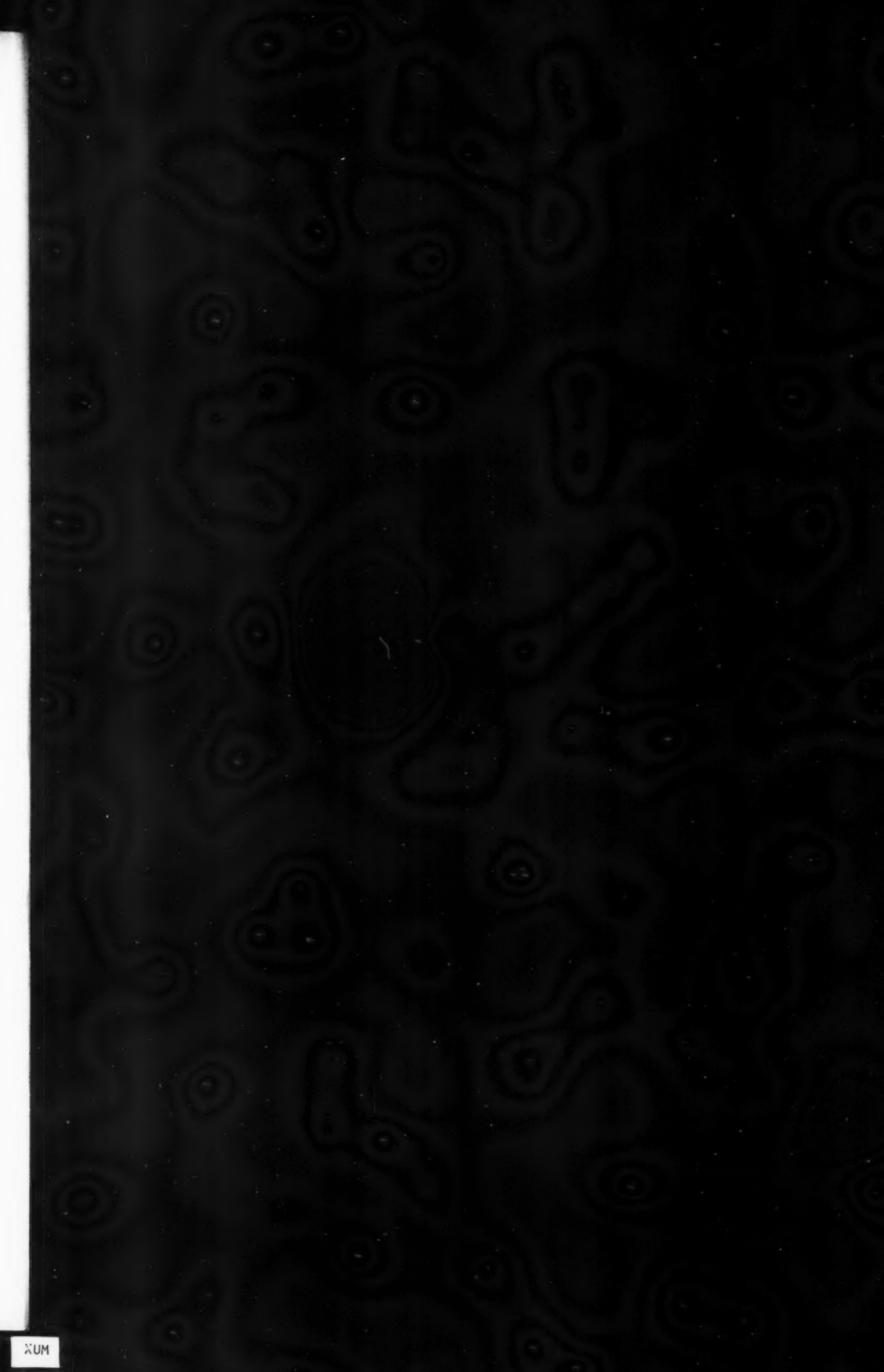
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